chita City Librar

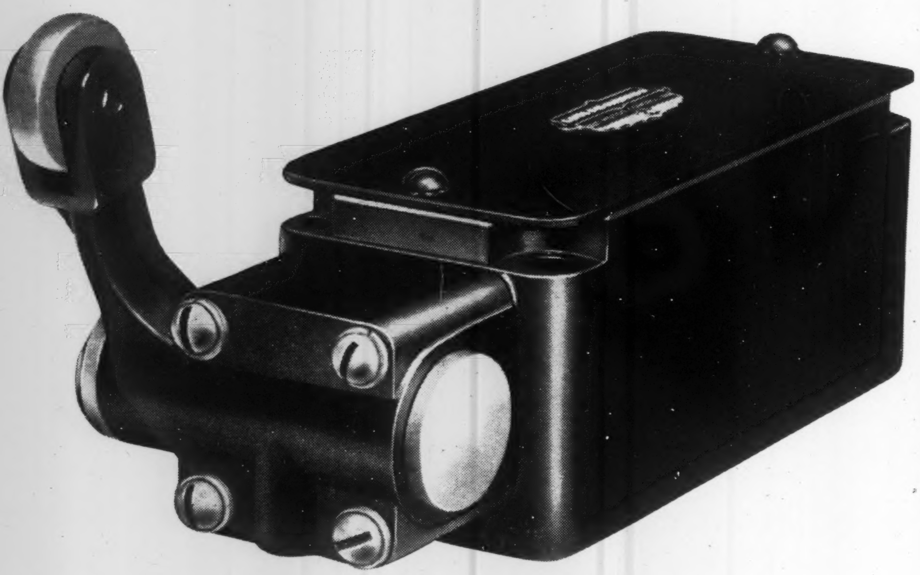
MACHINE DESIGN

June 1947

In This Issue: A NEW APPROACH TO DESIGN
HELICOPTER CONTROLS . . . LOCKING FASTENERS

STOP!

THIS SNAP ACTION LIMIT SWITCH HAS MANY FEATURES, MANY USES

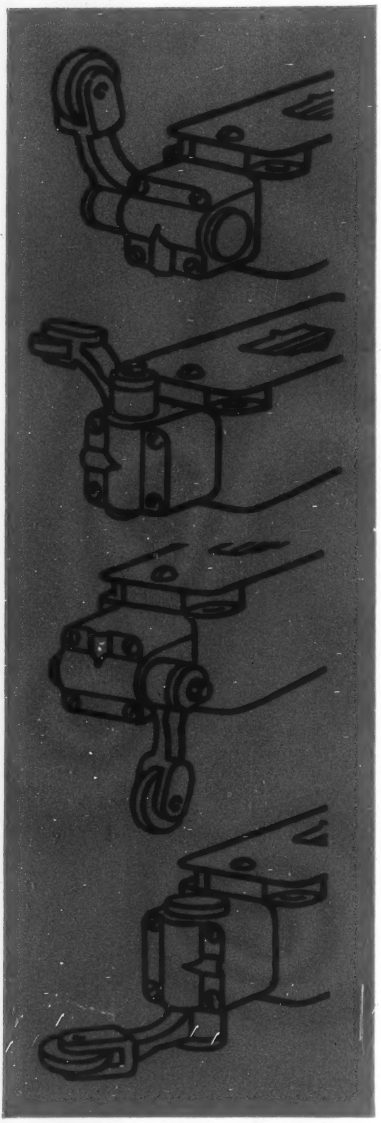


The Cutler-Hammer Bulletin 10316 Limit Switch, available in roller lever, push roller or push rod operating heads, all of which are interchangeable, meets many different needs on machines, machine tools, cranes and hoists. The roller lever type is furnished either with trip in both directions or with trip in one direction and by-pass in the other direction.

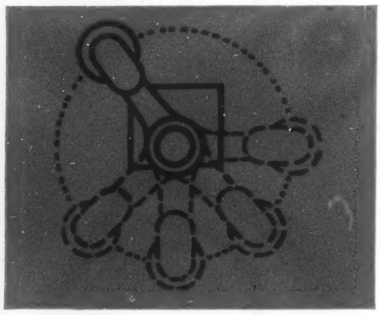
The operating head mounts in any of 4 quadrants. The roller lever can be set positively in 90 different operating positions (4° apart). Thus any machine mounting or field requirement is easily met.

Each switch has two circuits: normally open and normally closed. Adjustable contacts provide various arrangements of overlap, or no overlap. Switch can be used to initiate automatic cycles, to reverse motor or as a stop on overtravel.

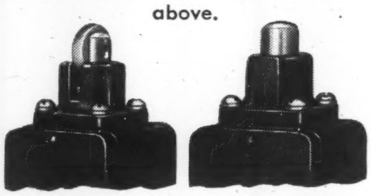
Construction is exceptionally sturdy with large bearings and hardened surfaces. Twin break silver to silver contacts, quick make and break, unvarying tripping points. Maximum ease of wiring, adjustment and accessibility. Standard, dustproof, dusttight, watertight or oiltight enclosing case. Complete details on request. . . . CUTLER-HAMMER, Inc., 1310 St. Paul Ave., Milwaukee 1, Wisconsin.



Operating head mounts in any of 4 positions, top, bottom, right or left shown above.



Roller lever may be set in any of 90 different positions, 4° apart as shown above.



Push roller or push rod operating head also available.

CUTLER-HAMMER

MOTOR CONTROL

C-H

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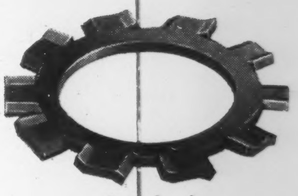
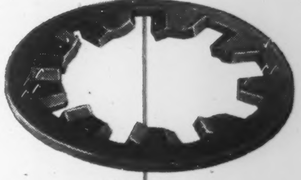
More Gripping Area

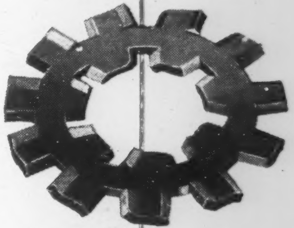
...WHEN AND WHERE IT COUNTS!



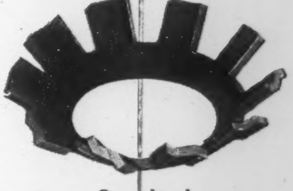
Standard External EverLock



Standard Internal EverLock



Standard Internal-External EverLock



Standard 80° Countersunk EverLock

- Here's photographic evidence that EverLOCK washers really take hold with a grip that defies every loosening action. Note how EverLOCK wide chisel edges have dug into the contiguous faces of both work and nut to provide several times more area of resistance than other washers.

Guard your assemblies with EverLOCK . . . The Washer That Has The Edge. Fast, easy application saves assembly time—automatically safeguards against stretching of bolts or distortion of threaded parts. Four standard types meet most lock washer needs.

Ever LOCK WASHERS

THE WASHER THAT HAS THE EDGE

THOMPSON-BREMER & CO. 1636 W. HUBBARD STREET, CHICAGO 22, ILLINOIS

A Page for the *Designer's Notebook*

On "Perfect" Oil Seals—Their Characteristics

1. Retain lubricant and exclude both moisture and foreign-matter to give bearings and operating mechanisms maximum protection.
2. Applicable to shafts, horizontal, vertical or placed at any angle, within or protruding from a mechanism.
3. Suitable for use with any standard lubricant.
4. Resistant to oils, greases, water, acids and alkalis.
5. All steel encased—self-contained and ready to press into place in bearing housing or elsewhere in the assembly.
6. Require just a minimum of design space.
7. Self adjusting in operation—no take-up, no maintenance, consequently, they can be used in inaccessible locations.
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10. Sealing member is anchored and cannot rotate with the shaft.
11. Sealing member materials will not wick away lubricant from protected bearings.
12. All dimensions held to extremely close tolerances for accurate fitting.
13. Choice of 18 different models with size range from ¼″ to 48″ OD.
14. Twenty years of successful industrial service with performance records on which to base design for new applications.
15. Chicago Rawhide engineers available for consultation and to save your time.

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MACHINE DESIGN

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This Month's Cover: Rotor of Bell helicopter. Stabilization of the aircraft is achieved through reaction of weights at ends of the bars located beneath the rotor blades. Problems of helicopter control and stabilization are discussed in the article beginning on Page 101.

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PLAIN TUBE

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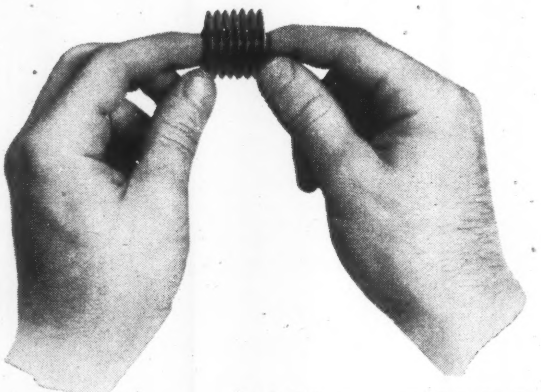
OR ITS EQUIVALENT SURFACE AREA

in

WOLVERINE TRUFIN



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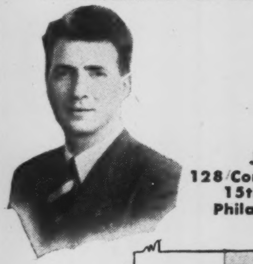
In heat transfer work, Wolverine Trufin surface is generally considered all prime surface — not secondary surface. In calculating a given heat transfer problem, unknown factors are eliminated — your calculations need not involve intangibles.

WHO'S WHO AMONG WOLVERINE REPRESENTATIVES



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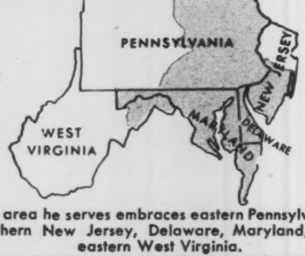

The area he serves embraces eastern Pennsylvania, southern New Jersey, Delaware, Maryland, and eastern West Virginia.

Trufin will deliver a very high rate of BTU's per square foot. Being all-one-piece — the fins extruded from the tube itself — Trufin will withstand vibration and extreme heat changes.

Trufin — THE integral finned tube — will do everything that plain tube will do — and along with that, offers increased surface area. It can be formed and bent as readily as plain tube.

WOLVERINE TUBE DIVISION
CALUMET & HECLA CONSOLIDATED COPPER COMPANY
MANUFACTURERS OF SEAMLESS COPPER & BRASS TUBING
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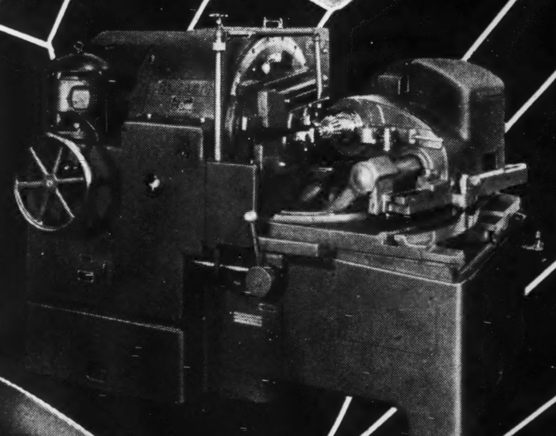
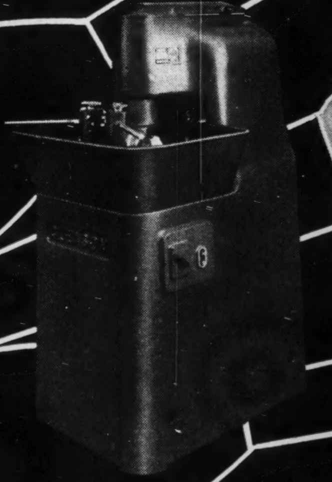
MAINTAIN QUALITY

QUALITY IN BEVEL GEARS starts with the gear generator itself. Gleason straight bevel gear generators are built to cut gears accurately . . . to the very latest design. For example, Coniflex gears, the straight bevels with localized tooth bearing, are cut on the new Gleason straight bevel generators.



MAINTAIN QUALITY by constant control of gear production . . . test gears for desired tooth bearing . . . keep tools sharpened for smoothness of surface finish and accuracy . . . all are fundamental to making better bevel gears. That is why the Gleason No. 13 Universal Tester and the No. 12 Generator Tool Sharpener are an integral part of every straight bevel gear cutting department.



The No. 12 Generator Tool Sharpener sharpens the tools to a smoothness of surface finish and accuracy demanded by modern bevel gear applications and assures long life of the cutting tools employed.

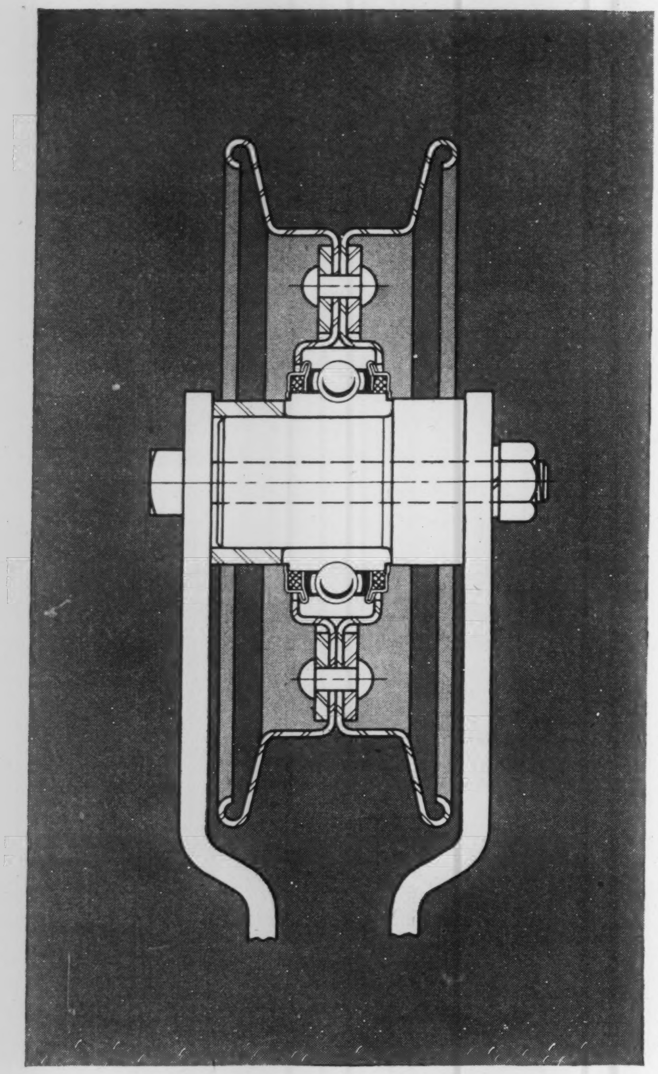
A running test on the No. 13 Universal Tester

1. Establishes correct setup for gear generator before production.
2. Assures maintenance of uniform quality of gears during production.
3. Finds best position for gears in final assembly.

GLEASON Works

1000 University Avenue
Rochester 3, N.Y., U.S.A.

Builders of Bevel Gear Machinery for Over Eighty Years

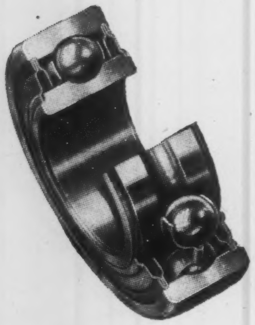


The New Departure self-sealed, lubricated-for-life ball bearing is a natural for the machine manufacturer too, because it is an easily applied unit, protected against dirt in handling—and helps keep his product working when neglect and carelessness enter the picture.

THE *Never* INDOLENT IDLER

This ball bearing idler is used to tension the cylinder drive belt in a Combine Harvester. It's the kind the busy farmer appreciates because it is always on the job — never takes up *any* of his precious time for maintenance.

And, it is one kind of idler that is never lazy — doesn't get gummed up and turn hard if neglected, because it is lubricated-for-life — never needs bearing adjustment — is always easy running regardless of belt tension. It is *built-to-be-forgotten.*



Nothing Rolls Like a Ball

NEW DEPARTURE
BALL BEARINGS
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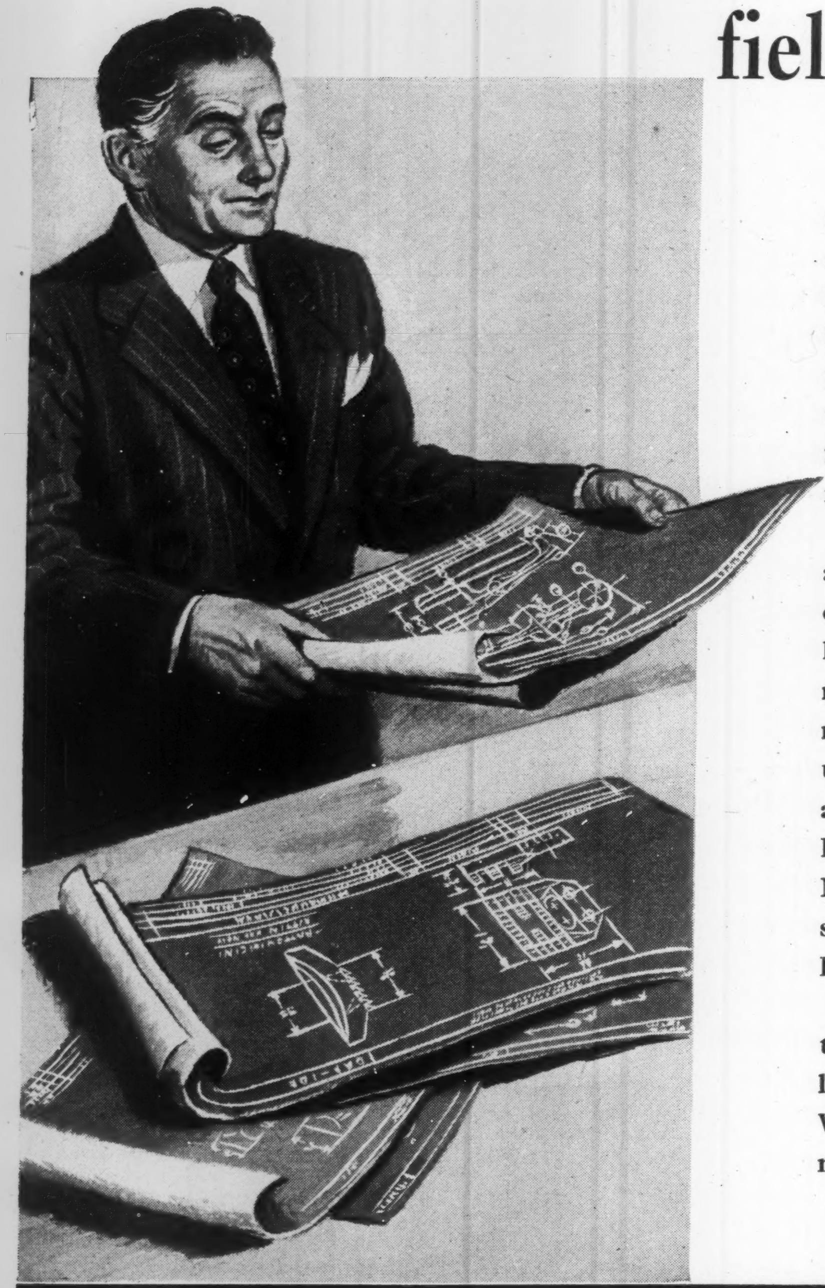
Have FABRICATING PROBLEMS limited your field of design?



Your parts can be engineered for material and performance rather than convenience of fabrication if you specify HAYNES precision castings. Parts of intricate design can be produced in production quantities by this process to close dimensional standards so that finishing operations are reduced to a minimum.

HAYNES precision castings are available in a wide range of alloys that dominate the field where strength and hardness at high temperatures, and resistance to abrasion or corrosion are required. Among the alloys having this unique combination of properties and available as precision castings are HAYNES STELLITE, HASTELLOY, and MULTIMET alloys. Various stainless steels also are precision-cast by the HAYNES method.

Our engineers will be glad to discuss the possibility of producing your problem parts by HAYNES precision casting. Write to any office for further information.

The registered trade-marks "Haynes," "Haynes Stellite," "Hastelloy," and "Multimet" distinguish products of Haynes Stellite Company.

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Alloys

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Unit of Union Carbide and Carbon Corporation
UCC
General Offices and Works, Kokomo, Indiana
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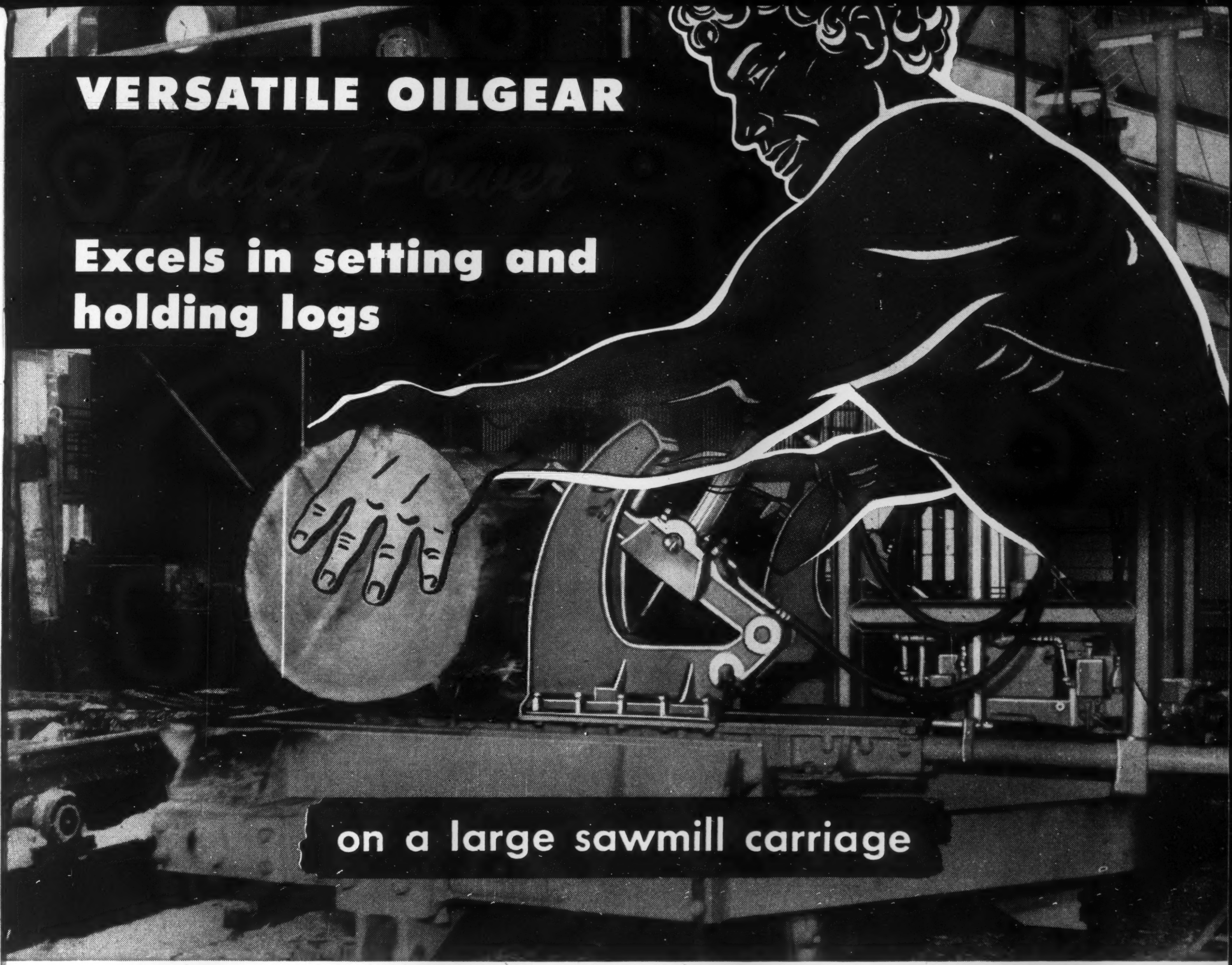

VERSATILE OILGEAR
Fluid Power
Excels in setting and holding logs
on a large sawmill carriage

Logs larger than 40 inches diameter must be sawed into cants before they are fed to the chipper in this mill. Speed in grabbing and spotting the log for band sawing is vital. Experience shows no power can be applied or reversed as smoothly and rapidly as fluid power so the Soundview Pulp Co. of Everett, Washington, selected Oilgear, foremost in fluid power, to operate the setworks and holding dogs on their sawmill carriage.

Two Oilgear fluid power pumps supply a sudden thrust of power to two dog cylinders for gripping the long log, they maintain a pre-selected pressure on the dogs indefinitely without power-loss or overheating and they actuate two setworks cylinders to quickly move the large log to and from the sawing position.

The above is only one of many applications of Oilgear Fluid Power in the lumber, pulp and paper industries. This versatile power performs any conventional rotary, straightline or reciprocating function besides a number of others that cannot be performed with other power transmission equipment. Write for further information or ask an Oilgear engineer to show you how Oilgear Fluid Power can solve your problem. THE OILGEAR COMPANY, 1305 W. Bruce St., Milwaukee 4, Wisconsin.

Typical Oilgear uses in lumber, pulp and paper mills

Drives for log carriages, barkers, turners, niggers, paper machines, calenders, winders, unwinders, etc.... Feeds for carriages, edger rolls, surfacers, saws, etc.... Holddowns for pulp grinders, paper machine presses, calenders, etc....

Oilgear Fluid Power

OILGEAR

Trademark Reg. U. S. Pat. Off.

ARE YOU TRYING TO:

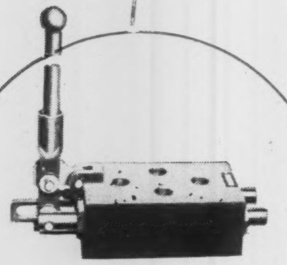
1. Apply large forces through long . . . or short . . . strokes at variable speeds?
2. Obtain automatic work cycles, variable speeds in either direction . . with or without preset time dwell?
3. Apply large forces through continuous or intermittent reciprocating cycles at constant or variable velocities?
4. Obtain extremely accurate control of either position or speed of a reciprocating member?
5. Apply accurately variable pressure either static or in motion?
6. Closely synchronize various motions, operations or functions?
7. Apply light . . or heavy . . . forces at extremely high velocities through either long or short distances of travel?
8. Obtain continuous automatic reversing drives at constant R.P.M. or over a wide range of speed variation?
9. Obtain accurate remote control of speed and direction of rotation, rates of acceleration and/or deceleration?
10. Obtain constant horsepower output through all or part of a speed range?
11. Obtain automatic torque control?
12. Obtain accurately matched speed of various rotating elements?
13. Obtain constant speed output from a variable speed input?
14. Obtain full preset automatic control. elimination of problems of shock, vibration, etc.?

You Need Oilgear!

HUNT

Quick-As-Wink Valves

give safe, positive control in Crown Cork and Seal Strip Mill

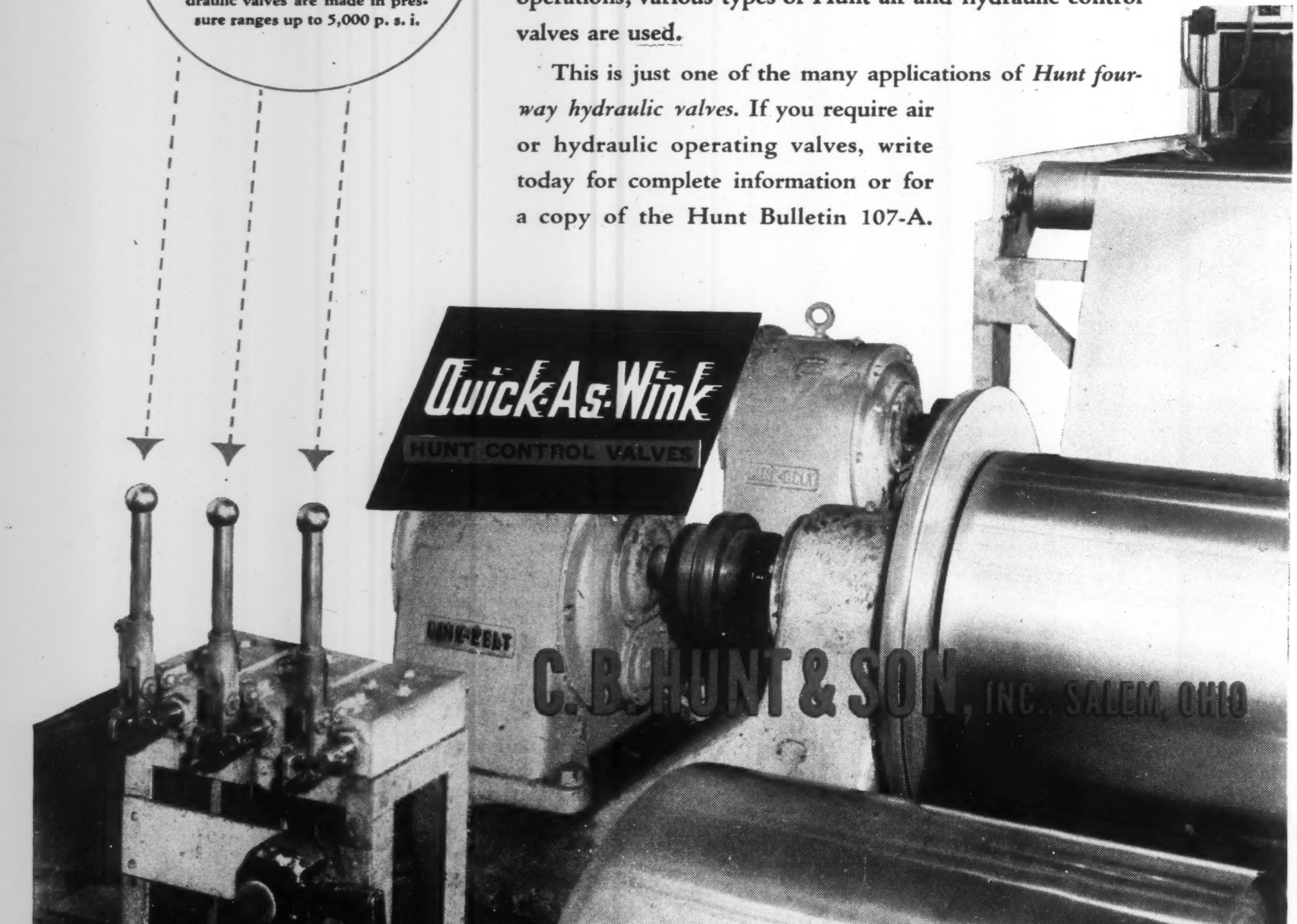


Hunt 4-way, lever-operated hydraulic valves are made in pressure ranges up to 5,000 p. s. i.

● This illustration shows three 4-way, neutral position valves handling 1000 pounds pressure and used for controlling coil holders at entry end of continuous strip annealing furnace. The two end valves operate the reel heads on the clamping mechanism while the center valve operates the coil elevator.

The Crown Cork and Seal Company are the world's largest producers of bottle caps and in their many diversified manufacturing operations, various types of Hunt air and hydraulic control valves are used.

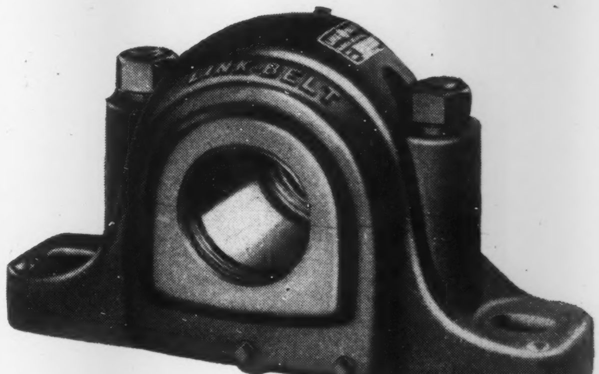
This is just one of the many applications of *Hunt four-way hydraulic valves.* If you require air or hydraulic operating valves, write today for complete information or for a copy of the Hunt Bulletin 107-A.

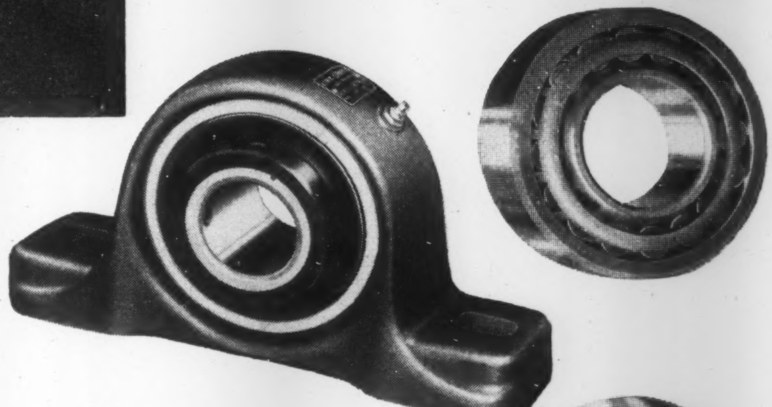


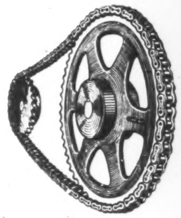
Quick-As-Wink
HUNT CONTROL VALVES

C. B. HUNT & SON, INC., SALEM, OHIO

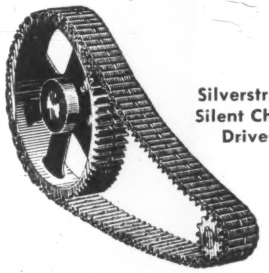
POWER TRANSMISSION MACHINERY *by* LINK-BELT *Serves All Industry*







Silverlink Roller Chains and Sprockets



Silverstreak Silent Chain Drives

LINK-BELT BALL AND ROLLER BEARINGS

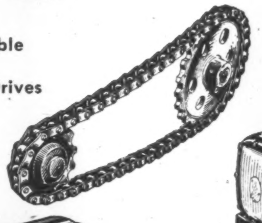
ASSURE SERVICE SATISFACTION

Engineering principles and manufacturing methods of Link-Belt Ball and Roller Bearings are all pointed to the one objective: the assurance of "service satisfaction" to the user. They have many outstanding features which are making major contributions to that objective. Link-Belt bearings can be furnished in pillow blocks, cartridge, flanged, take-ups, hanger and duplex units or without mountings for machine applications, etc.

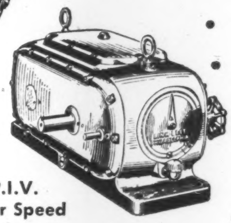
LINK-BELT COMPANY

THE LEADING MANUFACTURER OF CONVEYING AND MECHANICAL POWER TRANSMISSION MACHINERY

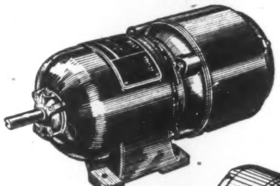
Chicago 9, Indianapolis 6, Philadelphia 40, Atlanta, Dallas 1, Minneapolis 5, San Francisco 24, Los Angeles 33, Seattle 4, Toronto 8. Offices, Factory Branch Stores and Distributors in Principal Cities. 10,619



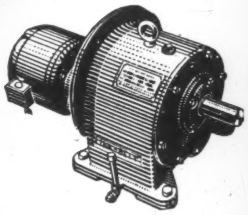
Steel, Malleable and Promal Chain Drives



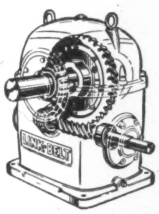
P.I.V. Gear Speed Variators



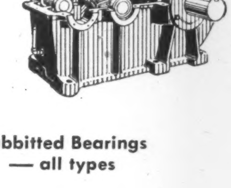
Electrofluid Drives



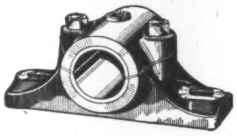
Motorized Helical Gear Speed Reducers



Worm Gear Speed Reducers



Herringbone Gear Speed Reducers



Babbitted Bearings — all types

THE SYMBOL OF QUALITY LB LINK-BELT

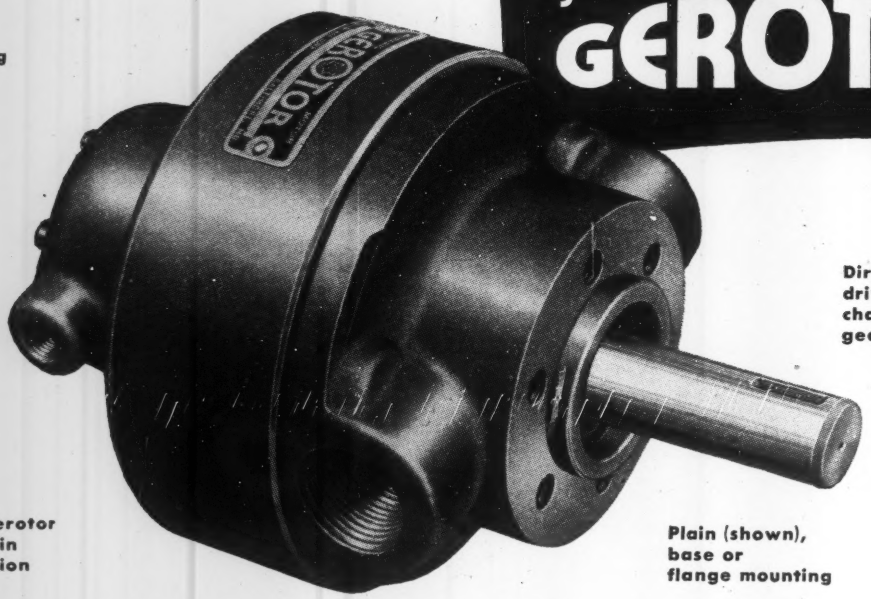
LINK-BELT *Power Transmission Machinery*

DOES JOBS no other rotary power source can do!

the new

hydraulic motor

by GEROTOR


Sturdy axial thrust bearing
External or internal drain
Anti-friction shaft bearings
Basic Gerotor principle—low relative Gerotor speed
Outer Gerotor element in anti-friction bearing
Direct coupling drive or belt, chain or gear drive
Plain (shown), base or flange mounting
GEROTOR

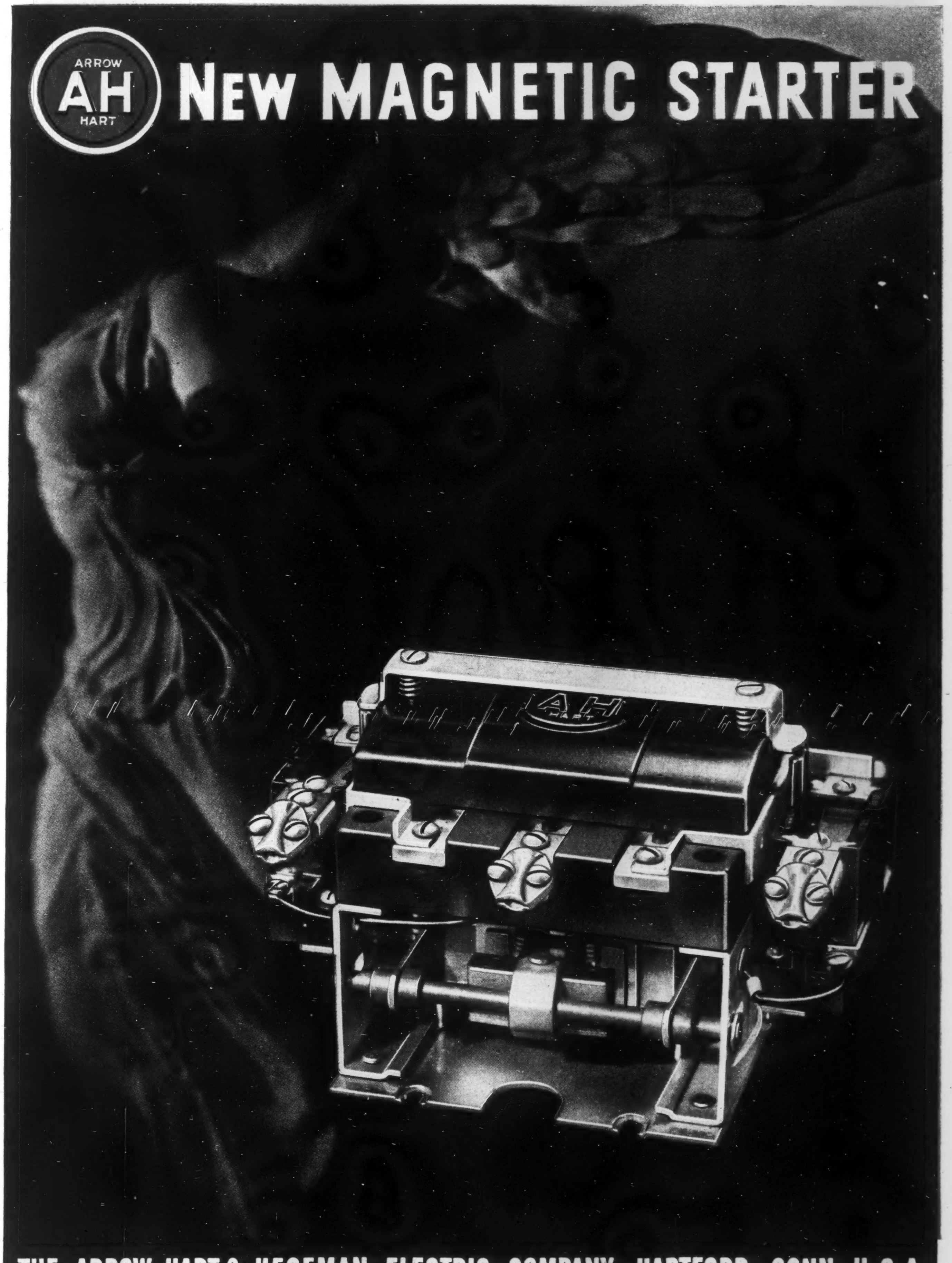
Converts hydraulic power into rotary power. Low rotational inertia permits infinite, rapid changes in shaft speed and direction. Can be stalled under load without damage—operated in explosive and corrosive atmospheres—installed in small, confined spaces.

Sizes up to 8.7 h.p. Write for further details.

GEROTOR MAY CORP. ▪ BALTIMORE 3, MD.

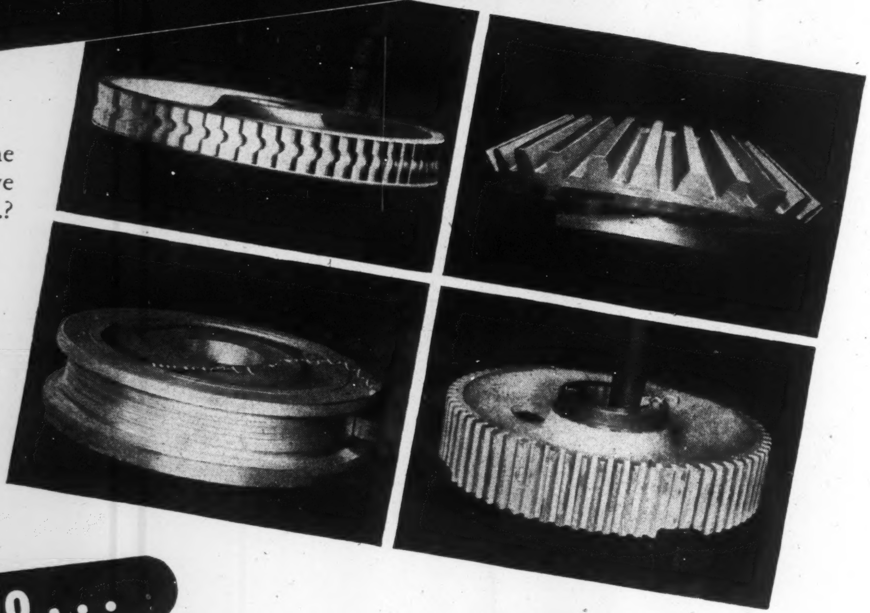
GEROTOR

hydraulic motors • pumps • pump units • valves • cylinders


ARROW AH HART
New MAGNETIC STARTER
AH HART

THE ARROW-HART & HEGEMAN ELECTRIC COMPANY, HARTFORD, CONN., U. S. A.

DO YOU MASS-PRODUCE ROUND STEEL PRODUCTS?

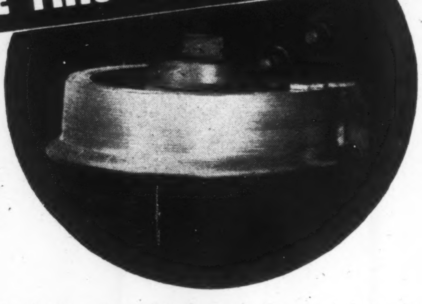


Such as spur and bevel gears? Crane wheels? Turbine rotors, sheave wheels, flywheels, tire molds, etc.?

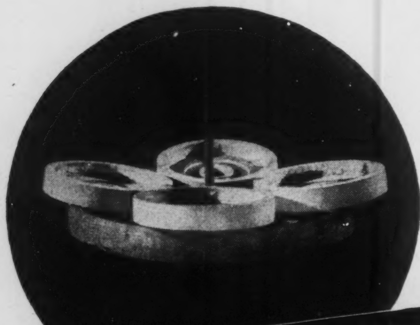
IF YOU DO . . .

Then there's much to be gained by using Bethlehem's rolled-and-forged circular blanks. They're made by a process that assures high strength and other excellent physical properties. The fine quality of these forgings often makes possible thinner sections—hence savings in weight. Other savings we'll tell you about in a moment.

YOU'LL LIKE THIS THRIFT-APPEAL:



All Bethlehem rolled-and-forged blanks are rough-machined before they leave our plant. This means less machining for *you*—a point of economy well worth considering.



AND HERE'S SOMETHING ELSE

The blanks are available in carbon or alloy steel, untreated or heat-treated as required. Sizes range from approximately 10 in. to 44 in. OD. We'll be glad to furnish full details.

BETHLEHEM STEEL COMPANY, BETHLEHEM, PA.

On the Pacific Coast Bethlehem products are sold by
Bethlehem Pacific Coast Steel Corporation

★ BETHLEHEM STEEL ★

BETHLEHEM ROLLED-and-FORGED CIRCULAR PRODUCTS

This Seal Marks—
"Truly a Lifetime Motor"
©

FRACTIONAL HP
REP.-IND. TYPE

INTEGRAL HP
DIRECT CURRENT
MOTORS

INTEGRAL HP
POLYPHASE AND
REP.-IND TYPE

DEPENDABILITY LONG LIFE
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EXPLOSION PROOF
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INTEGRAL HP
ENCLOSED
FAN COOLED TYPE

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FRACTIONAL HP
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FAN COOLED

POWER POISE
FRACTIONAL HP
CAPACITOR TYPE

FRACTIONAL HP
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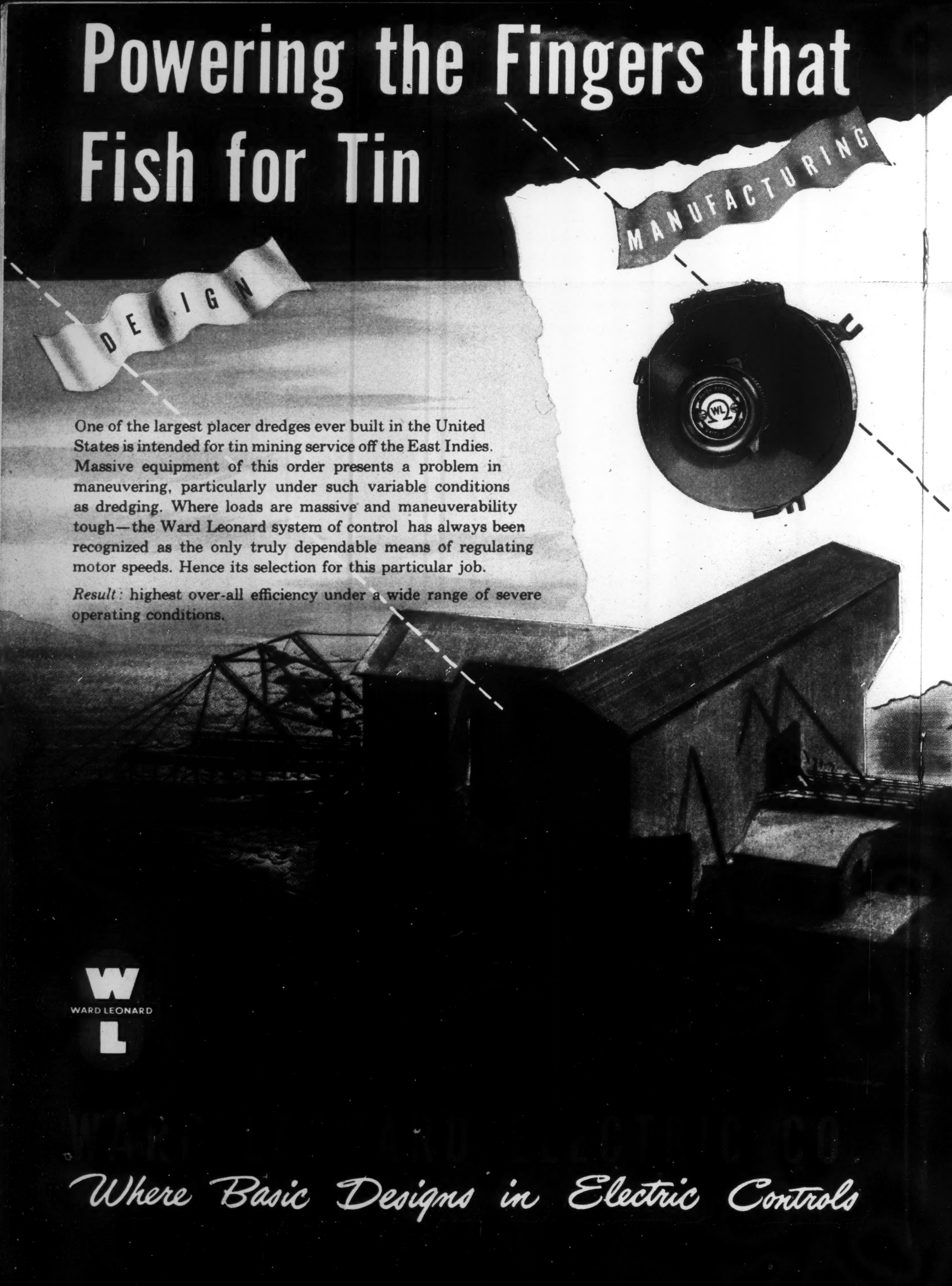
NON VENT

WRITE FOR
MOTOR BULLETIN 5000
GRINDER BULLETIN 7000

THE BROWN-BROCKMEYER COMPANY
LEADING INDEPENDENT MOTOR MANUFACTURER
1030-1048 SMITHVILLE ROAD
DAYTON 1, OHIO
PLANTS AT DAYTON, WILMINGTON, WASHINGTON AND XENIA, OHIO—OFFICES IN PRINCIPAL CITIES



Powering the Fingers that Fish for Tin

One of the largest placer dredges ever built in the United States is intended for tin mining service off the East Indies. Massive equipment of this order presents a problem in maneuvering, particularly under such variable conditions as dredging. Where loads are massive and maneuverability tough—the Ward Leonard system of control has always been recognized as the only truly dependable means of regulating motor speeds. Hence its selection for this particular job.

Result: highest over-all efficiency under a wide range of severe operating conditions.

W
WARD LEONARD
L

WARD LEONARD ELECTRIC CO

Where Basic Designs in Electric Controls

TAPPED AND POWERED TO SUIT THE CASE

Ward Leonard Rheostats are the controlling elements in the Ward Leonard System of Control. Ward Leonard Field Rheostats are arranged with 72 to 165 steps of solid brass rectangular contacts and a copper graphite shoe providing the smoothest possible control. For generator fields they are available in several multiples of field resistance values and designed for a straight line relation between the steps of the rheostat and field current.

These rheostats are available in every known kind of mounting, in single and multiple plate, open or enclosed, manual or motor drive.

Result: accurate selection of the right rheostat with complete confidence of trouble-free performance.

RESULT-ENGINEERED Without "CUSTOM-ENGINEERING" Costs

Knowing the result you want to obtain with an electric control, it is often possible to modify a Ward Leonard basic design to meet your specific requirements more efficiently and without the usual high cost of a "special".

BLUE MEANS *esult- ngineering*

In resistors, rheostats, relays and other electric controls, the distinctive blue identifies Ward Leonard "result-engineering".

FREE BULLETINS on "Result-Engineered" Rheostats

Please request on business letterhead, mentioning your title

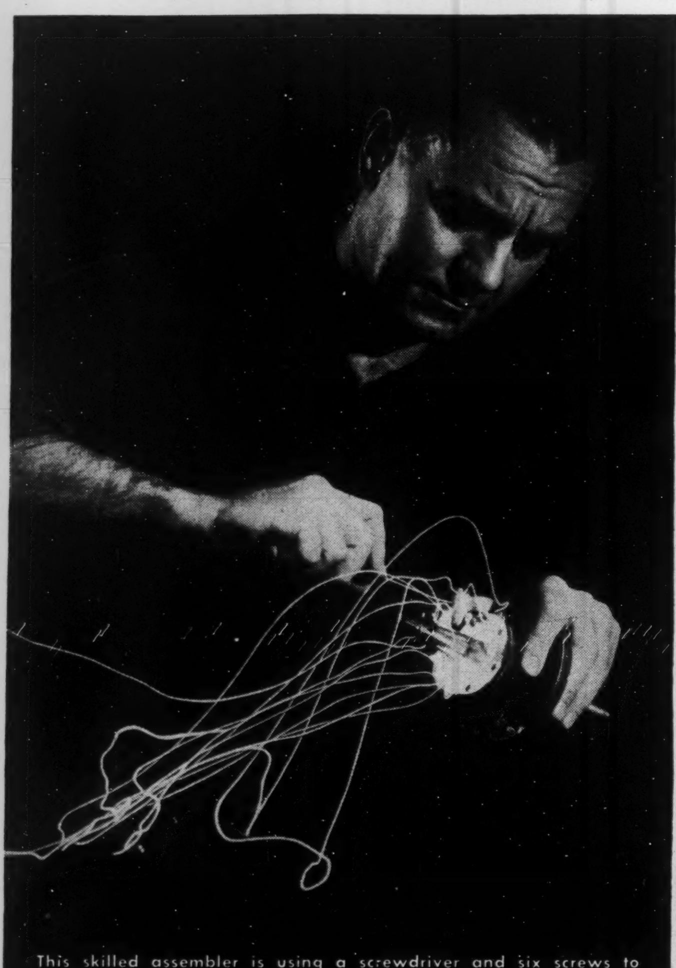
WARD LEONARD ELECTRIC CO.

Mount Vernon, New York • Offices in principal cities of U. S. and Canada

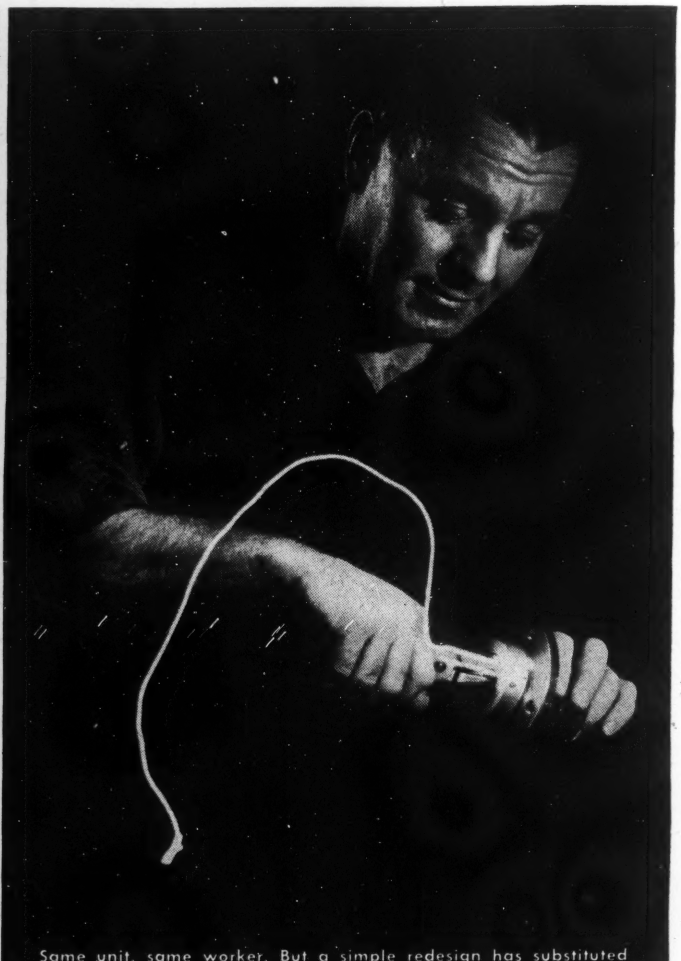
RESISTORS • RHEOSTATS • RELAYS • CONTROL DEVICES

Waldes TRUARC retaining rings

2 MINUTES vs. 2 SECONDS!



This skilled assembler is using a screwdriver and six screws to install a collar. Each of the many light streaks indicate another time-consuming arm-motion, with less efficiency and greater fatigue.



Same unit, same worker. But a simple redesign has substituted a Truarc ring for the collar and screws. He uses one tool—a pair of Truarc pliers. A single light streak means fewer arm-motions.

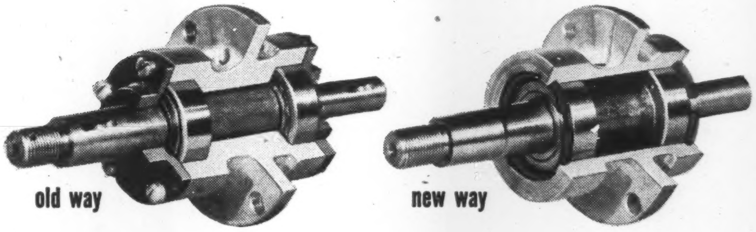
Right before your eyes is visual proof of how much assembly time can be cut. It's done simply by replacing conventional fastening devices with Waldes Truarc Retaining Rings. Less time is required for job-training, because Truarc guarantees accurate relationship of parts independent of the skill of the assembler. Inspection is simplified, rejections reduced—and the product will function longer without repair.

This new fastening does wonders for machine design. Truarc rings mean lighter weight, less bulk, maintenance of tolerances. Production and maintenance men find Truarc cuts labor and material costs wherever used. Its unique taper design assures constant circularity. Its never-failing grip assures a better job of holding machine parts together. Yet Truarc rings are easily removed and re-installed in a few seconds.

Wichita City Library

slash assembly time, cut costs

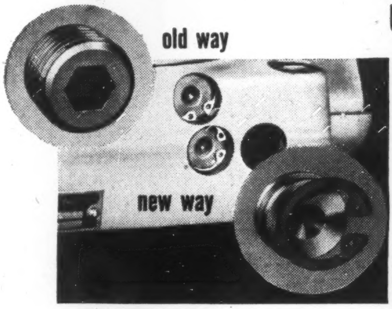
Typical cost-cutting applications:



TRUARC TRIMS 13 MINUTES' MACHINING TO 6

Permits redesign of exhaust-fan bearing-housing for M. & E. Manufacturing Company, Indianapolis. Truarc cuts assembly time 66%, trims 25% off weight of unit, lowers labor and material costs.

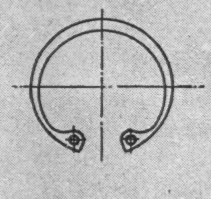
TRUARC ELIMINATES 12 OPERATIONS, CUTS UNIT COST 65 CENTS



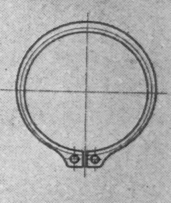
Changeover to Truarc in hydraulic Powerpak cuts assembly time over 50% for Electrol, Inc., Kingston, N. Y. Permits use of semi-skilled assemblers, cuts maintenance time more than half.

Your designs can easily be adapted to secure Truarc's advantages. See what can be done for your product: send your drawing to Waldes Truarc Technical Service Engineers for individual attention, without obligation.

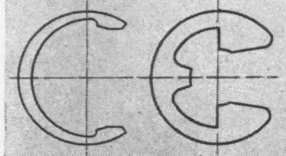
THERE ARE DIFFERENT TRUARC RINGS FOR ANY APPLICATION:



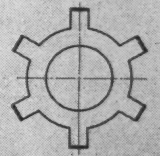
STANDARD.* Replaces bulky, complicated devices; simplifies assembly.



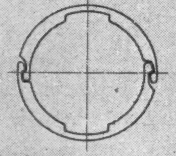
BEVELED* and BOWED.* Absorb end-play rigidly or resiliently where tolerances accumulate.



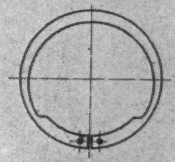
CRESCENT and E-RING. Snap on radially where axial assembly is impossible. Give firm grip.



SELF-LOCKING.* Economical where thrust is moderate — housing requires no machining.



INTERLOCKING. 2-piece ring for heavy thrusts, positive lock against high RPMs and vibration.

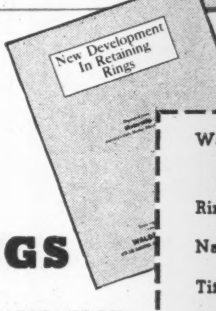


INVERTED.* Uniform shoulder for abutting curves, for bearings with large corner radii.

*Available for both external and internal applications.

WALDES
TRUARC
Reg. U. S. Pat. Off.
RETAINING RINGS

WALDES KOHINOOR, INC., LONG ISLAND CITY 1, NEW YORK
Canadian Distrib.: Controlite Engineering & Sales Ltd., 20 Bloor Street W., Toronto 5



● *Mail this coupon today for your copy of "New Development in Retaining Rings."*

Waldes Kohinoor, Inc., 47-10 Austel Place 21-P
Long Island City 1, N. Y.
Please send booklet, "New Development In Retaining Rings" to:
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Company__________
Business Address__________
City______Zone______State______

WALDES TRUARC RETAINING RINGS ARE PROTECTED BY U. S. PATS. 2,302,948; 2,026,454; 2,416,852 AND OTHER PATS. PEND.

STAINLESS STEEL

Don't Peek Over His Shoulder

If you'd like to keep up-to-date on the multitude of uses for stainless steel you may have a copy also. For ELECTROMET REVIEW will bring this news to you in quickly readable form. And since the publication covers everything from motor boats to pots and pans, your special interest is bound to be in there, too. So if you wish us to add your name to the 23,000 other industrial executives, designers, and architects who receive ELECTROMET REVIEW free of charge each month, just drop us a note, to Department D-6 Room 308.

ELECTRO METALLURGICAL COMPANY
Unit of Union Carbide and Carbon Corporation
30 East 42nd Street UCC New York 17, N. Y.

PRODUCERS OF ALLOYS THAT MAKE STEEL STAINLESS

Beautiful Enduring Strong Tough

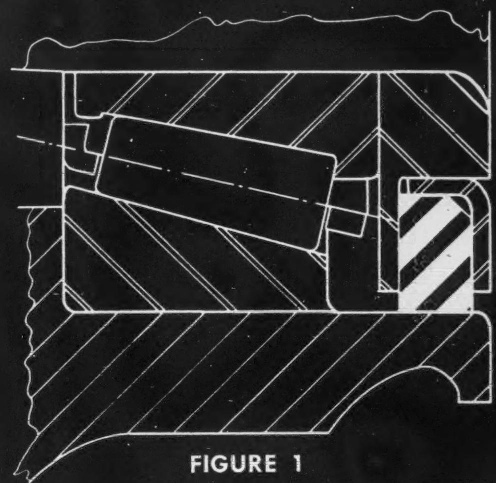


FIGURE 1

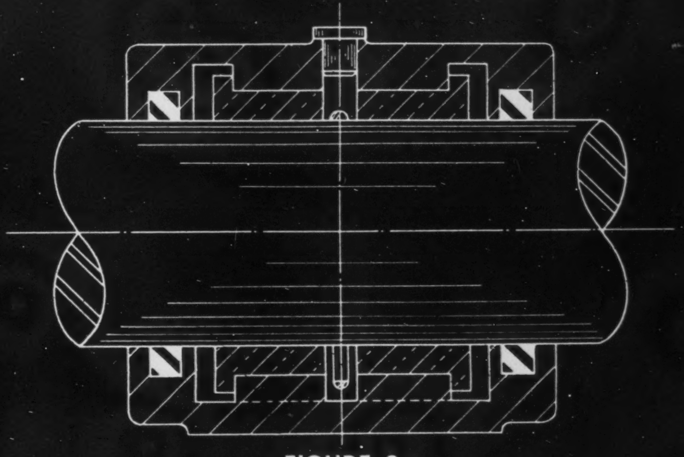


FIGURE 2

SEALING ROTATING PARTS EFFICIENTLY

Factors favoring use of simple, compressible rings

A compressible ring, placed either in a counterbore or in a groove, offers an effective yet simple means of sealing rotating parts. Properly designed and installed, such a ring is non-binding, non-scoring. It can be made comparatively small in cross section when space must be conserved. Since it does not depend for its effectiveness upon springs, fingers, or other mechanical parts, it is relatively low in cost.

Armstrong's Cork-and-Synthetic-Rubber Compositions make excellent ring-type seals. These compositions combine the oil resistance and strength of synthetic rubber with the true compressibility of cork. Under compression, each air-filled cell of cork acts, in effect, as a self-contained spring. Constant pressure is maintained against the moving part without extrusion of the sealing medium.

To insure radial compression when assembled, cork-and-synthetic-rubber rings are normally designed with the I.D. $\frac{1}{64}''$ scant, the O.D. and the thickness $\frac{1}{32}''$ full. These allowances, however, are influenced by the size of the ring, the speed of the sealed part, and by the pressures involved.

Shown above in Figure 1 is an application of a cork-and-synthetic-rubber ring used as a roller-bearing grease shield. The designer of this unit had first specified an impregnated fabric for the shield, but the fabric proved to be too rigid. Fabric also was expensive, for it had to be cut from sheet material. The final answer was a lathe-cut ring of Armstrong's DC-100. This oil-resistant material gave the permanent resiliency required, was more easily assembled, had lower initial cost and had a longer service life. Half rings or strips also can be supplied for use in split housings as illustrated above in Figure 2.

While cork-and-synthetic-rubber compositions are high-friction materials, binding is easily prevented by applying oil, grease, or other lubricants to the ring. One lubrication lasts for the life of the seal. Lubricant can be applied either in your factory or ours.

Since minor design details often exert great influence on the choice of a sealing material, we suggest that you call in an Armstrong Representative before setting up specifications. He'll be glad to suggest suitable materials and supply samples for testing.

If you prefer, send drawings and details directly to Armstrong's Gaskets and Packings Dept. You'll find our recommendations unbiased and keyed to good current sealing practice.

ARMSTRONG'S

SEND FOR FREE BOOKLET.

For specification and application data on Armstrong's more than 50 resilient sealing materials, send for a free copy of the latest edition of "Gaskets, Packings, and Seals," twelve pages of helpful information. Address Armstrong Cork Company, Gaskets and Packings Department, 5106 Arch Street, Lancaster, Penna.

ARMSTRONG'S
GASKETS · SEALS · PACKINGS

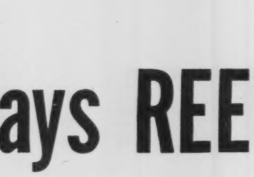
Cork Compositions • Cork-and-Synthetic-Rubber Compositions
Synthetic Rubber Compounds • Cork-and-Rubber Compositions
Fiber Sheet Packings • Rag Felt Papers • Natural Cork

1 to 8

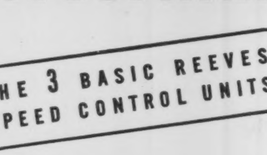
Ways REEVES Speed Control Can Improve Performance of the Machines You Build

THE 3 BASIC REEVES SPEED CONTROL UNITS

VARIABLE SPEED TRANSMISSION for providing infinite, accurate speed flexibility over a wide range—2:1 to 16:1. Sizes—fractional to 87 hp.



VARI-SPEED MOTOR PULLEY converts any standard constant speed motor to a variable speed drive within 4:1 ratio. Sizes to 15 hp.



MOTODRIVE combines motor, speed varying mechanism and reduction gears in single compact unit. Speed variations 2:1 to 6:1 inclusive. Sizes to 15 hp.

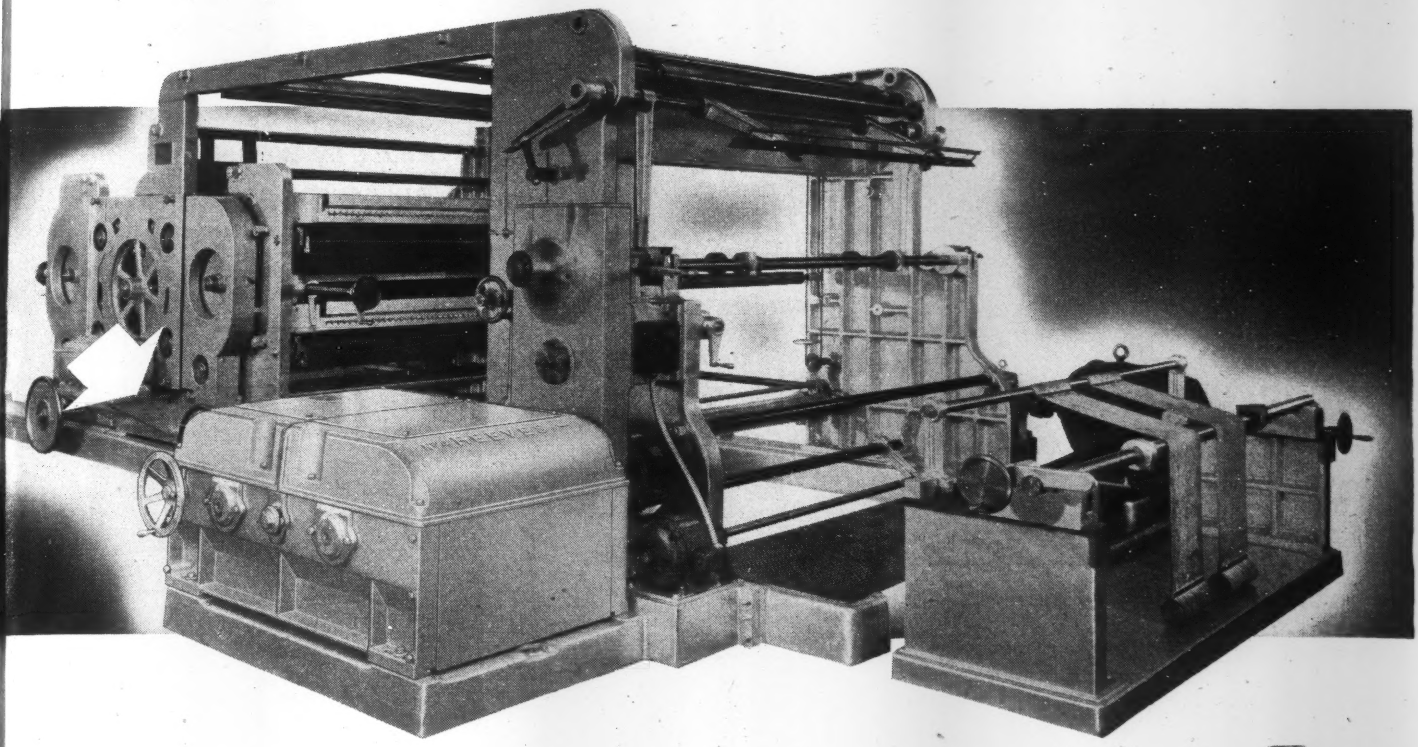
● For the new production machinery you are building or blueprinting, follow the lead taken by the manufacturers of more than 2,100 different makes of machines and specify Reeves Speed Control as standard equipment.

Providing accurate, infinite and instant speed adjustability . . . assuring the right speed for every operation and every operator under every changing condition . . . Reeves Variable Speed Drives make any machine more flexible and more versatile because the Reeves-equipped machine can perform from "1 to 8" of these essential production jobs:

1. Handle more sizes, shapes and materials—provide a wider work range.
2. Match variances in number or skill of operators.
3. Compensate for change in consistency, density or viscosity of materials in process.
4. Accurately control heating, baking, drying, cooking or chilling time.
5. Maintain uniform peripheral speed (or tension) on decreasing or increasing diameters.
6. Maintain uniform pressure, weight, liquid level, temperature and other variable elements.
7. Regulate conveyor speeds—even to fractions of an inch per minute.
8. Synchronize all working parts—of one machine or machines operating in series.

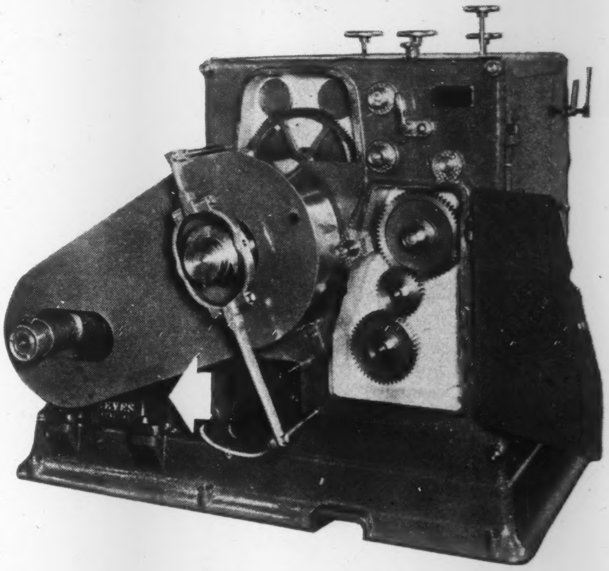
So, for increased production of uniform and improved quality—at lower cost—choose from the complete line of ruggedly built, easily maintained Reeves Speed Control units. You'll find the widest selection of designs, sizes, speed ratios and controls (the latter including push button and completely automatic), as well as *internal operating parts only* for incorporation within the framework of your machines. Our experienced field engineers will be glad to consult with you on your particular application problems.

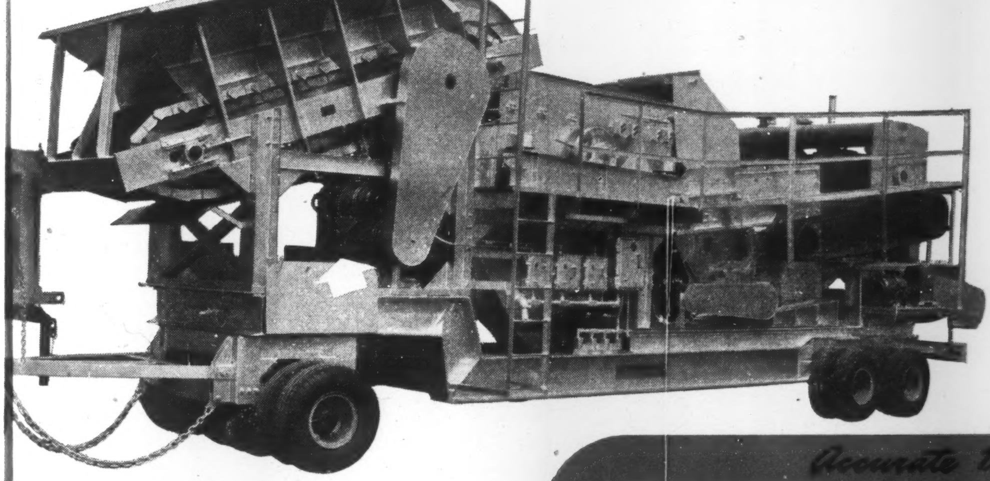
REEVES PULLEY COMPANY · COLUMBUS, INDIANA



This portable hammermill, product of the Dixie Machinery Manufacturing Company, St. Louis, Missouri, can produce 225 tons of agstone or roadstone per hour. By means of a REEVES Motodrive with which the plant is standardly equipped, speed of the apron type feeder may be varied instantly and accurately from 46.5 to 11.6 rpm to compensate for variations in moisture content of the material handled and to allow for changes in weather conditions which affect capacity of the vibrating screen.

The REEVES Variable Speed Transmission is standard equipment on this four-color, high-speed, heavy-duty paper web printer, manufactured by the Schmutz Mfg. Co., Louisville, Ky. The REEVES unit delivers the exact web speed required—up to 800 ft. per minute—for rewinding the printed paper on any size roll from 6″ to 48″.





This clutch type Universal Spring Coiler, manufactured by Sleeper & Hartley, Inc., Worcester, Mass., is designed to handle a wide variety of stock used in the manufacture of springs. By means of the REEVES Vari-Speed Motor Pulley with which the machine is standardly equipped, the ideal speed for working either light or heavy stock may be obtained instantly and maintained accurately.

Recognized Leader in the Specialized Field of Speed Control Engineering

Accurate Variable

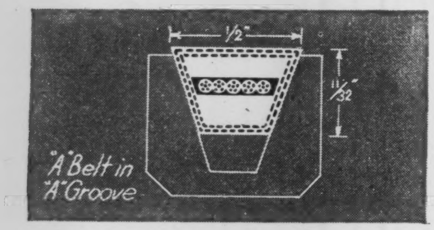
REEVES Speed Control

Gives the Right Speed for Every Job!

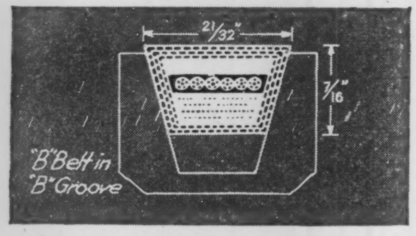
FINEST LOOKING SHEAVE ON THE MARKET!

Worthington QD Sheaves Are Custom Built to Fit the Belt

You now have a choice of tailor-made sheaves to suit your V-Belt Drive requirements exactly!


1/2"
11/32"
"A" Belt in "A" Groove

"A" Groove for "A" Belt

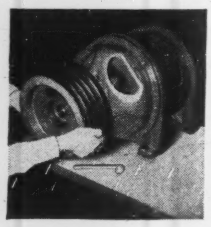

21/32"
7/16"
"B" Belt in "B" Groove

"B" Groove for "B" Belt

GROOVED TO YOUR PREFERENCE—an "A" belt rides flush in an "A" groove, and a "B" belt rides flush in a "B" groove—custom built—"A" for "A" and "B" for "B" . . . "it looks right"—is what you want—and you get a better-engineered, better-fitting, better-looking drive.

In addition, you get the *original* tapered cone grip sheave design—the best combination of the three basic sheave requirements 1. Easy to Get On—2. Easy to Get Off—3. Yet Always Tight on the Shaft.

The QD Sheave Clamps the Shaft Tighter than Any Other Sheave on the Market!



Note, too, the famous I-Beam Construction, providing strength where strength is needed most . . . The full-size pull-up bolts . . . The taper-mated hubs and rims . . . the offset design reducing overhang stresses . . . reasons why *there's more worth in Worthington.*

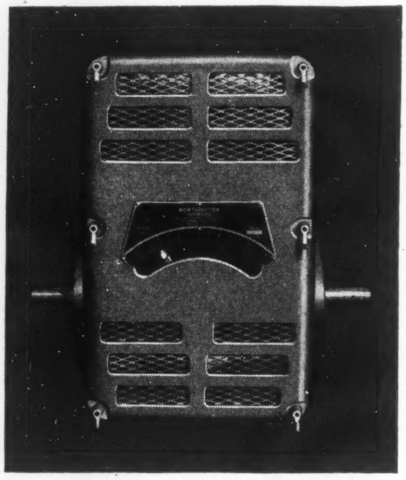
Ask your nearest Worthington District Office for complete details and for assistance in designing a Multi-V-Drive to suit your requirements. *Worthington Pump and Machinery Corporation, Merchandising Division, Harrison, New Jersey. 36 District Offices throughout the U.S.*

WORTHINGTON

NEW!

. . . Two More Allspeed Selectors Added by Worthington

YOU ASKED FOR THEM . . .
here they are—



Model D . . . 2 to 5 hp . . . 8-1 ratio . . . speed range 360/2880 (with 1725 RPM Input)

Model E . . . 2.8 to 7.5 hp . . . 6-1 ratio . . . speed range 400/2400 (with 1725 RPM Input)

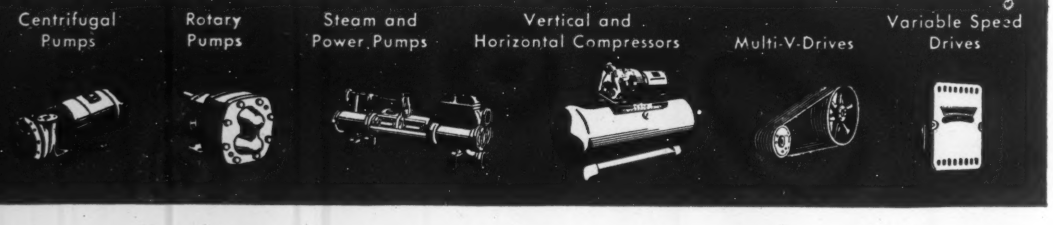
NOW GET ALLSPEED ADVANTAGES in the full range from ¼ hp to 7½ hp . . . Models A and C for lower horsepowers . . . D and E for higher horsepowers. All have these outstanding features . . . Tandem belt drive for compactness . . . automatic belt tensioning . . . quick belt change . . . wide selection of speed ratios.

Ask your nearest Worthington District Office for your copy of the Worthington Allspeed Selector Bulletin, and for help in choosing the right selector for your job.

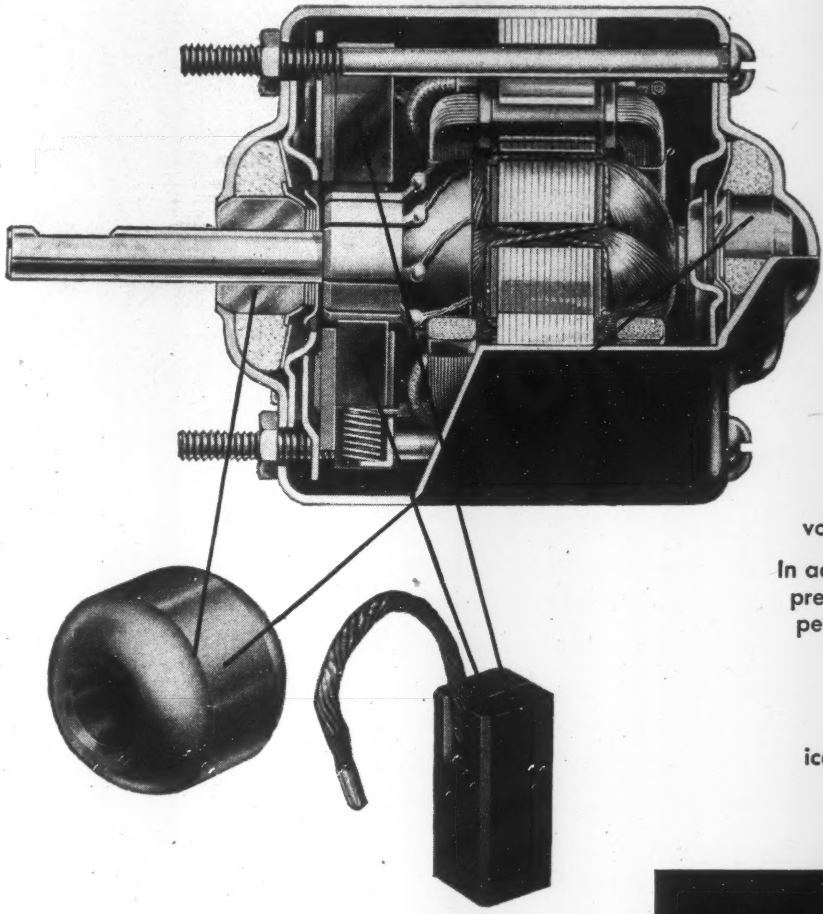
Worthington Pump and Machinery Corporation, Merchandising Division, Harrison, New Jersey. 36 District Offices throughout the U.S.

B7-2

PRODUCTS BASED ON MARKET RESEARCH


Centrifugal Pumps
Rotary Pumps
Steam and Power Pumps
Vertical and Horizontal Compressors
Multi-V-Drives
Variable Speed Drives

gramix bearings and U.S.G. brushes help insure efficiency of *Redmond* Micromotors

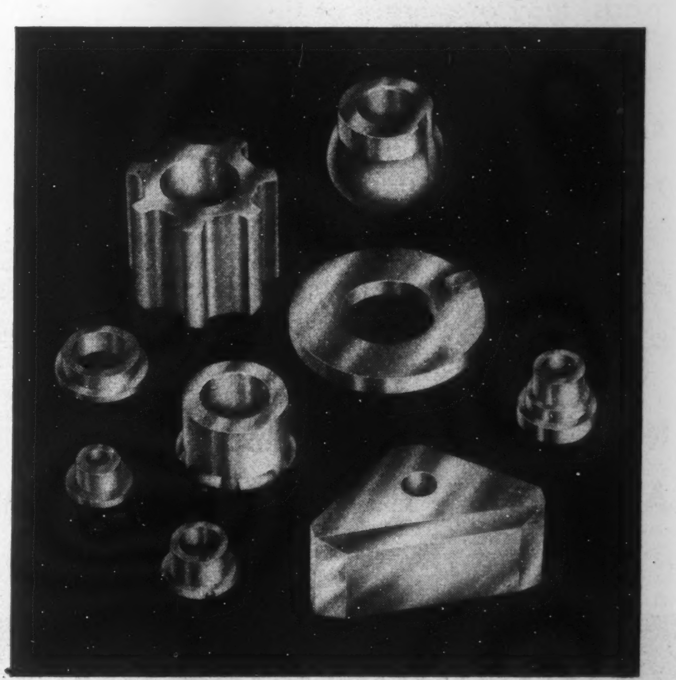


Gramix powder metal bearings and U. S. G. brushes are two important reasons for the outstanding dependability of Redmond Micromotors. U.S.G. copper-graphite brushes have high current carrying capacities and provide positive, noiseless commutator contact. The Gramix bearings reduce shaft play and noise, because they are self-aligning and are selectively fitted to the shaft to retain clearance within .0005". They provide automatic lubrication, with microscopic pores that filter lubricant from the reservoir and distribute it evenly and freely.

In addition, Gramix bearings cost less. They are die-pressed from powdered metal to exact size and with perfect bearing and sliding surfaces, eliminating costly machining. Send us sketches or descriptions of your products, and we will show you where Gramix bearings, washers, gears, and other powder metal parts will improve mechanical performance and save you money. WRITE TODAY FOR NEW GRAMIX CATALOG ***just off the press.***

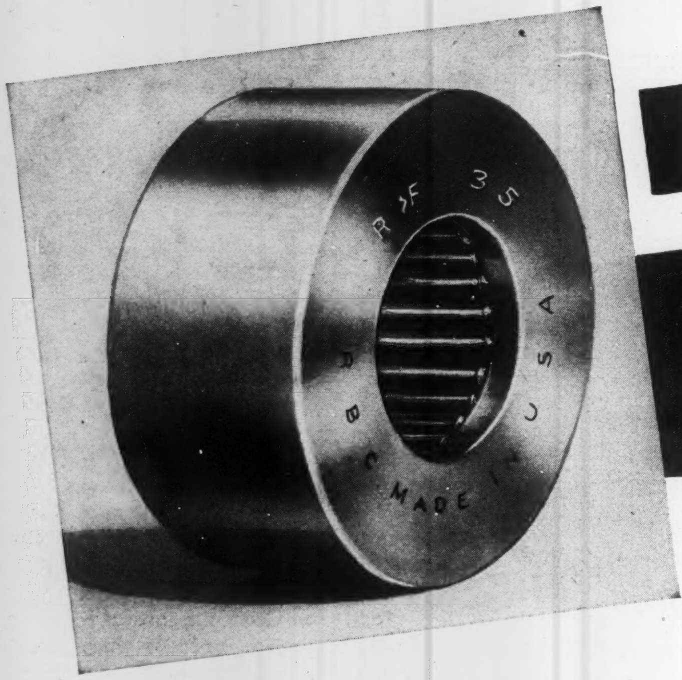
U.S.G. brushes

We manufacture a complete line of brushes for all types of rotating electrical equipment. Types include carbon-graphite, pure graphite, and metal-graphite with electrical carrying capacity ranging from 30 to 150 amperes per square inch. Our engineers will be glad to assist you in determining which grade and type of USG brush is best suited to your requirements.



gramix bearings
U.S.G. brushes

THE UNITED STATES GRAPHITE COMPANY • SAGINAW, MICHIGAN



RBC

New!

CYCLOPS SERIES

HEAVY WALL ROLLER FOLLOWERS

These Roller Followers are completely self-contained. They can be used directly on a hardened shaft or with standard CYCLOPS inner races. Designed to take heavy impact loads, they are made of fine alloy carburizing bearing steel.

These Roller Followers have been extensively made on ***special orders in individual sizes*** over a long period of years for use in internal combustion engines, printing presses, circuit breakers, jib cranes, lift trucks, automatic screw machines, locomotives, aircraft and many other successful applications.

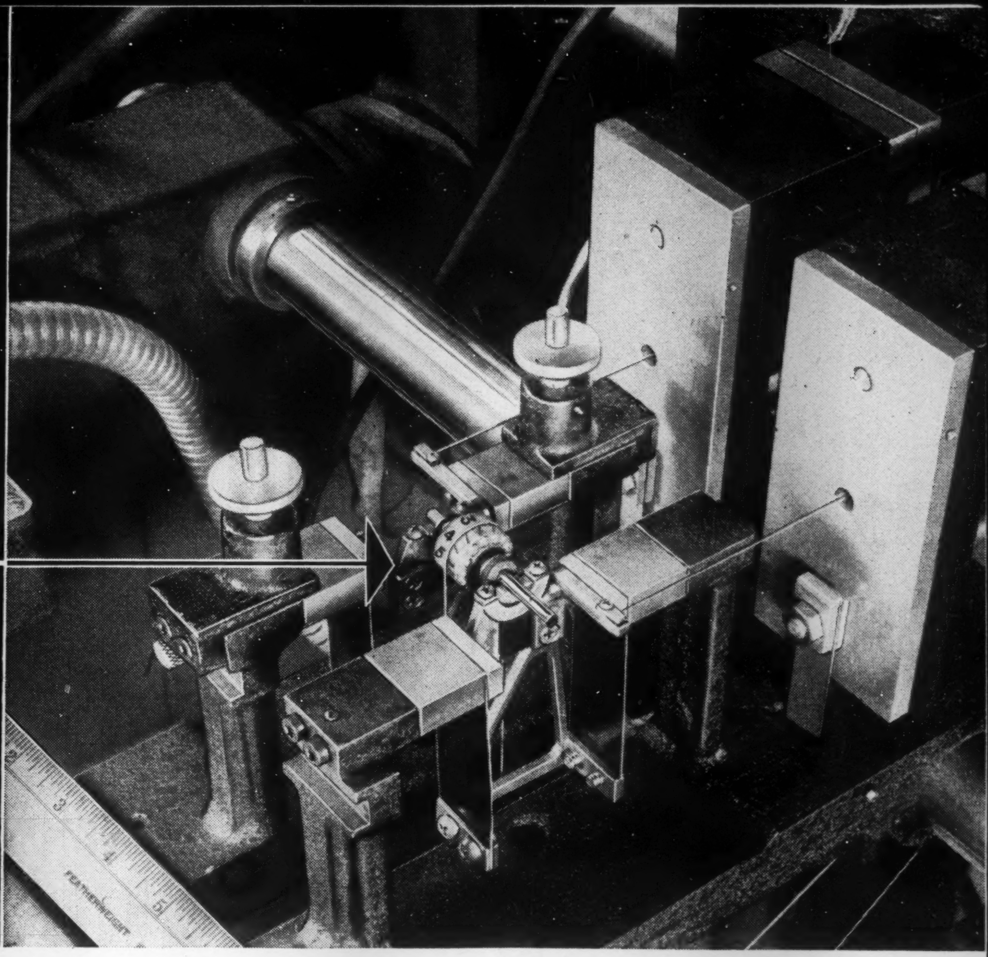
Now, For The First Time,
A COMPLETE STANDARD SERIES is Available

Send Coupon
below for
Size Information

ROLLER BEARING CO. of AMERICA, TRENTON, N. J.
Please send us Size Information on your new series
HEAVY WALL ROLLER FOLLOWERS
COMPANY NAME ....
ADDRESS ....
PER: ....
M

ROLLER BEARING CO. OF AMERICA
TRENTON, NEW JERSEY

IS BALANCING ON A DYNETRIC*x *important on such small parts?*

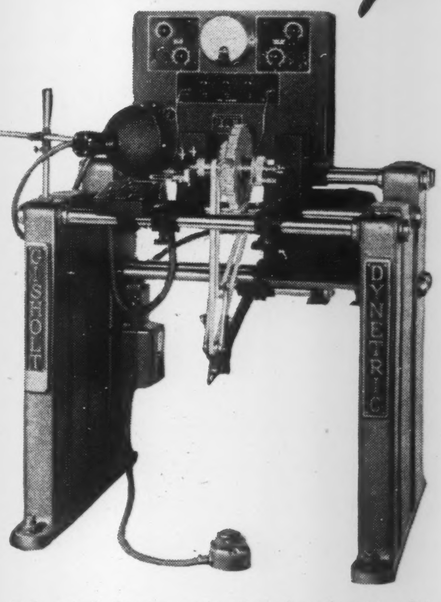


this manufacturer thinks so . . . *here's why . . .*

These tiny induction motors are used to operate record playing and record changing equipment. The manufacturer found that when armatures are not accurately balanced, considerable power is lost at the output shaft of the motor. Still worse, vibration in the record playing equipment not only impairs the tone quality of the machine but also shortens the life of the records it plays.

Where faithful reproduction is so important, is it any wonder the manufacturer protects his product by balancing these vital parts on a Dynetric machine? It is something to look for when you buy a phonograph.

And it is a good time to ask yourself where Dynetric Balancing can improve your product with smoother, quieter, vibrationless operation. Gisholt machines put balancing on a low-cost basis. Ask for the facts about them.



The Gisholt Dynetric 1S Balancing Machine handles parts up to 30 lbs. Other models are available to handle any size part from a fraction of an ounce to many tons. All provide a modern means for quickly measuring *and* locating *unbalance and for accurate correction. Write for literature.*

GISHOLT MACHINE COMPANY
Madison 3, Wisconsin

**Developed jointly with Westinghouse Electric Corporation*
x Trade-Mark Reg. U.S. Pat. Off. by Westinghouse Electric Corp.

GISHOLT

turret lathes • automatic lathes • superfinishers
balancing machines • special machines

THE GISHOLT ROUND TABLE
represents the collective experience of specialists in the machining, surface finishing and balancing of round or semi-round parts. Your problems are welcomed here.

SUPERB OIL RESISTANCE

is only one of Hycar synthetic rubber's unusual and valuable properties. Others are listed in the box at the right.

But most important, these properties may be had in an almost limitless number of combinations, each designed to meet specific service conditions of the finished Hycar part.

Our files contain more than 5000 recipes for Hycar compounds—each compound engineered to do a certain job. Parts made from HYCAR have seen service in *every* industry, giving long life, dependability, and economical operation.

That's why we say, ask your supplier for parts made from Hycar. Test them in your own application, difficult or routine. You'll learn for yourself that it's wise to use HYCAR for long-time, dependable performance. For more information, please write Department HN-6, B. F. Goodrich Chemical Company, Rose Building, Cleveland 15, Ohio.

CHECK THESE SUPERIOR FEATURES OF HYCAR

1. *EXTREME OIL RESISTANCE — insuring dimensional stability of parts.*
2. *HIGH TEMPERATURE RESISTANCE—up to 250° F. dry heat; up to 300° F. hot oil.*
3. *ABRASION RESISTANCE—50% greater than natural rubber.*
4. *MINIMUM COLD FLOW—even at elevated temperatures.*
5. *LOW TEMPERATURE FLEXIBILITY—down to —65° F.*
6. *LIGHT WEIGHT—15% to 25% lighter than many other synthetic rubbers.*
7. *AGE RESISTANCE—exceptionally resistant to checking or cracking from oxidation.*
8. *HARDNESS RANGE—compounds can be varied from extremely soft to bone hard.*
9. *NON-ADHERENT TO METAL—compounds will not adhere to metals even after prolonged contact under pressure. (Metal adhesions can be readily obtained when desired.)*

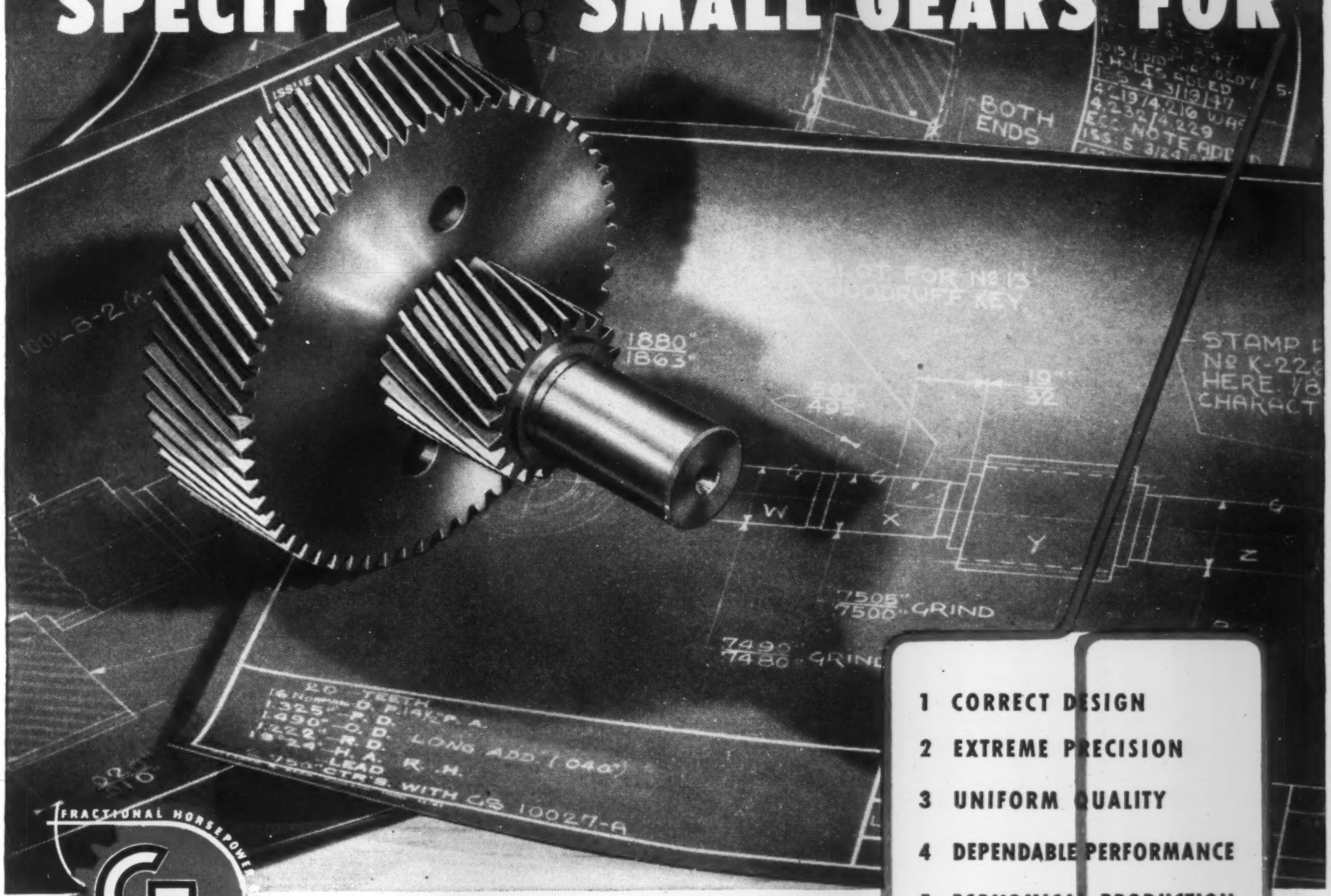
Hycar
Reg U S Pat Off

American Rubber

B. F. Goodrich Chemical Company

A DIVISION OF
THE B. F. GOODRICH COMPANY

SPECIFY G.S. SMALL GEARS FOR


BOTH ENDS
SLOT FOR No 13 WOODRUFF KEY
STAMP No K-22 HERE 1/8 CHARACT
.1880"
.1863"
.7505"
.7500" GRIND
.7490"
.7480" GRIND
20 TEETH
WITH GS 10027-A

1 CORRECT DESIGN
2 EXTREME PRECISION
3 UNIFORM QUALITY
4 DEPENDABLE PERFORMANCE
5 ECONOMICAL PRODUCTION
6 EFFICIENT SERVICE

SEND FOR OUR 4-PAGE BULLETIN

The G.S. Bulletin describes many different types and applications of G.S. Small Gears. Please ask for a copy on company stationery.

FRACTIONAL HORSEPOWER GEARING

If there was ever a place to get *better* Small Gears, *this is it!* . . and for very good reasons, too. Throughout a quarter century of intensive specialization . . years of constant research and progress . . we've developed the art of engineering and producing Fractional Horsepower Gears to a degree of perfection generally considered impossible a short time ago.

When you specify "G.S." for instance, you employ extensive facilities and an experienced organization of Small Gear Craftsmen. They can lend you valuable aid, not only in turning out *uniform* production runs, but also in establishing the *one* best design for the job the gear has to do. So . . whatever the problem . . put it up to a G.S. Engineer! Let him help you achieve the finest performance you've ever known from a Fractional Horsepower Gear! Ideas, information and cost estimates are yours for the asking. Will you write or phone us today?

IF IT'S A SMALL GEAR PROBLEM
Ask G.S.
GEAR Specialties

GEAR Specialties

Spurs • Spirals • Helicals • Bevels • Internals • Worm Gearing • Racks • Thread Grinding

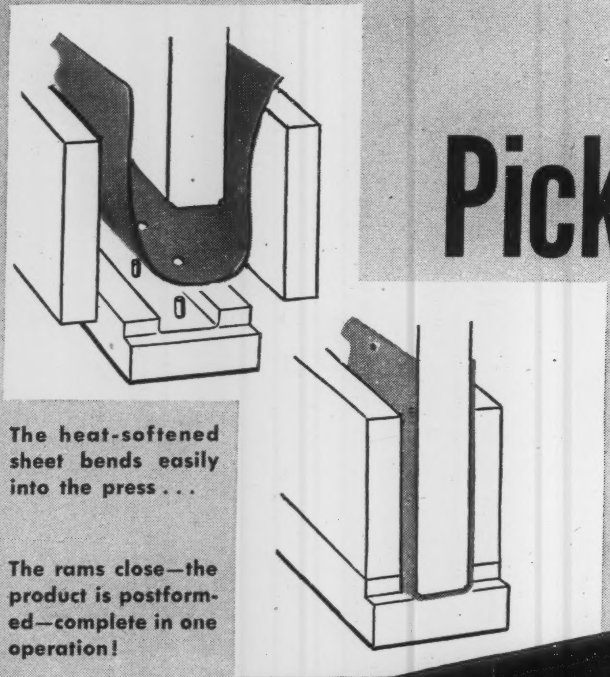
2635 WEST MEDILL AVENUE • CHICAGO 47, ILLINOIS

MEMBER OF AGMA

WORLD'S LARGEST EXCLUSIVE MANUFACTURERS OF FRACTIONAL HORSEPOWER GEARS

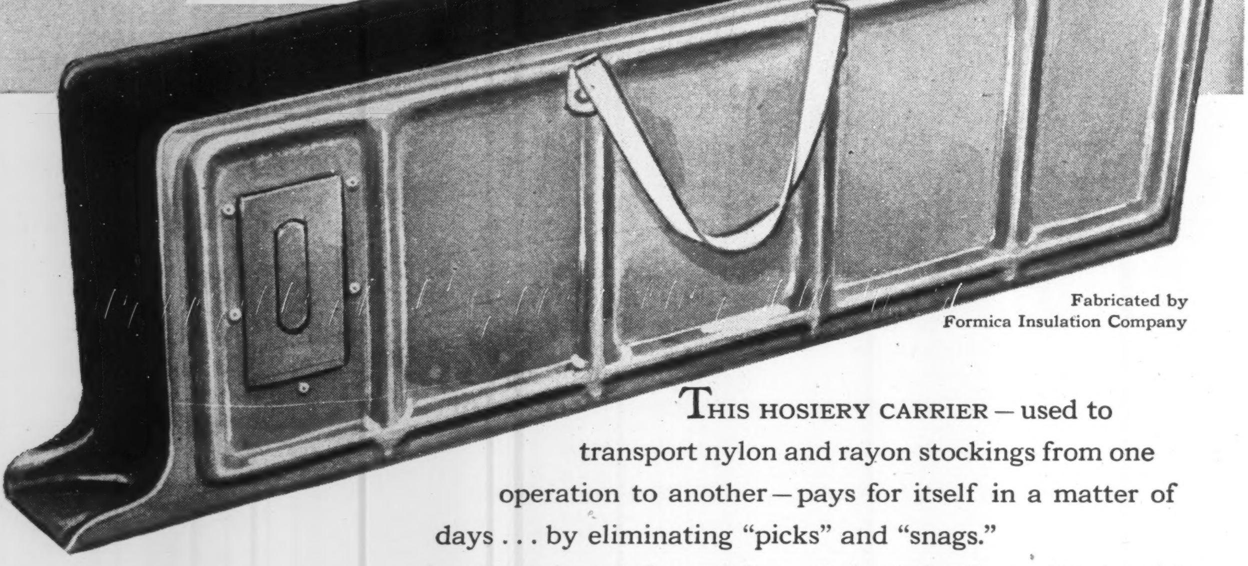
HOW CAN YOU DO IT BETTER...AND CUT COSTS?

Picks Plastics to Avoid "Picks"



The heat-softened sheet bends easily into the press...

The rams close—the product is postformed—complete in one operation!



Fabricated by
Formica Insulation Company

THIS HOSIERY CARRIER—used to transport nylon and rayon stockings from one operation to another—pays for itself in a matter of days... by eliminating "picks" and "snags."

Another triumph for *postformed* plastic laminates! Formed from flat laminated sheet impregnated with BAKELITE phenolic resins, these carriers are *smooth,* lightweight, and yet have the mechanical strength to withstand rough handling. They do not dent or corrode. They never develop rough spots or frayed edges to damage delicate merchandise.

Postforming of laminates is a new and growing technique in industry. Its applications are virtually limitless! Design engineers are eyeing its cost-saving possibilities.

Look into this important process! Write Department 15 for your copy of booklet "BAKELITE Laminating Plastics."

TRADE-MARKS

BAKELITE
LAMINATING PLASTICS

BAKELITE CORPORATION, *Unit of Union Carbide and Carbon Corporation* UCC 30 East 42nd Street, New York 17, N. Y.

INSIDE STORY... with a promise for you

This standard muffler practically fell apart — the outer shell has been cut away to show the disintegrated interior.

But now that the problem has been solved by making a durable muffler interior of Inconel, there is every reason to expect that this new muffler interior will last as long as the truck itself.

Even in grueling cross-country service trucks can go half a million miles nowadays.

But the mufflers can't.

They burn out, corrode away and shake themselves to pieces so fast that truck owners have to lay up a truck ten times or more during its life to put in another new muffler.

But a well-known manufacturer of trucks and buses got an idea. He realized that airplane exhaust stacks have to stand up under conditions far worse than any truck muffler ever meets: Yellow-white heat. Corrosive attack by flaming exhaust gases. Incessant vibration.

Those airplane stacks are made of Inconel*, an INCO Nickel Alloy especially suited for high temperature service. And it's nothing unusual for them to last a million flying miles.

Why not try Inconel for truck mufflers?

That's exactly what the manufacturer did. After exhaustive tests on fifteen other alloys in comparison with Inconel he reports —

> *"According to our tests, we believe Inconel to be good for the life of the vehicle."*

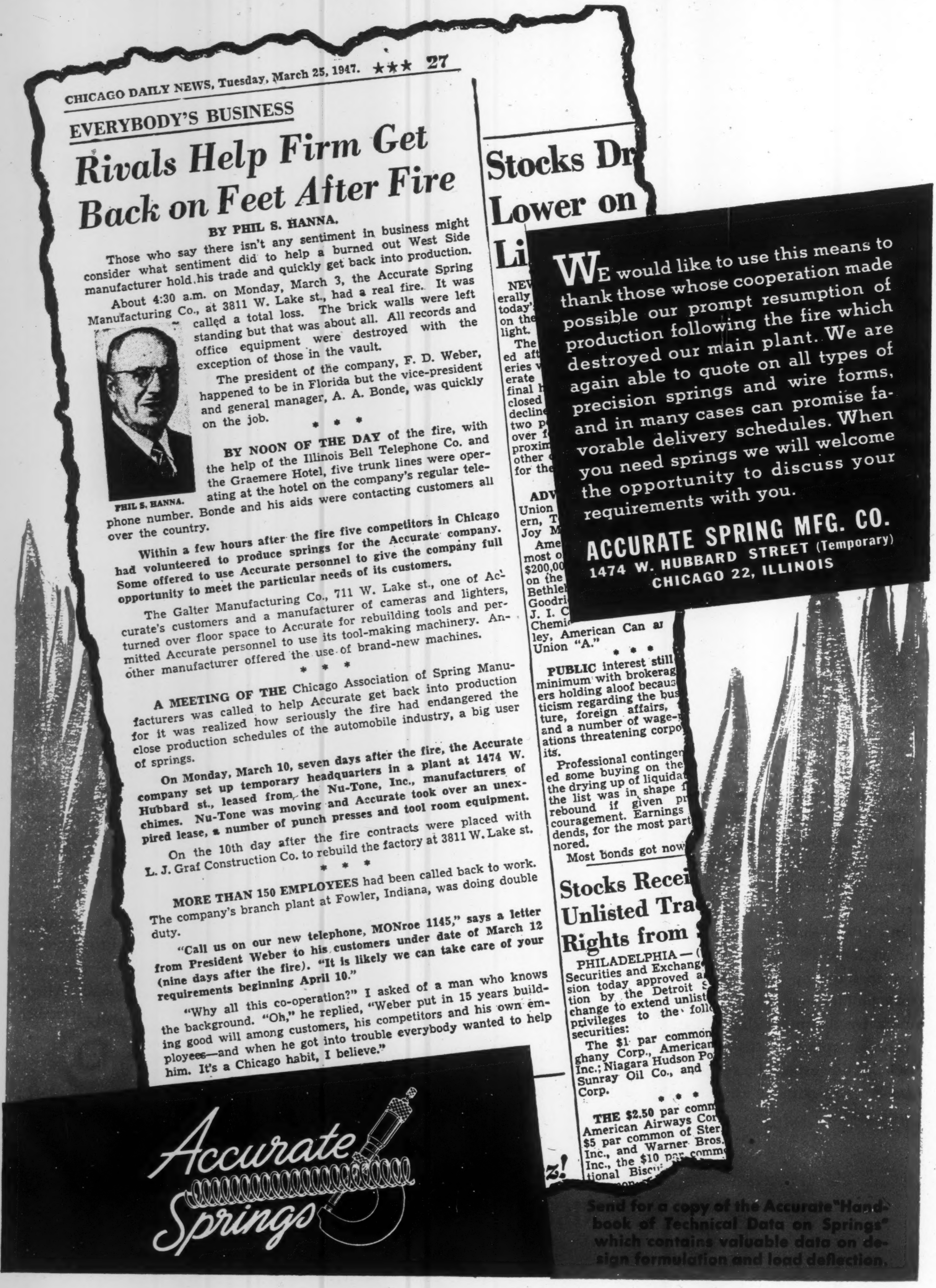
If *you* are looking for an answer to a high temperature problem, write for a copy of "Engineering Properties of Inconel." If your problem is different, one of the other strong, hard, corrosion-resisting INCO Nickel Alloys may be exactly what you want. Our technical assistance is yours whenever you ask for it.

THE INTERNATIONAL NICKEL COMPANY, INC.
67 WALL STREET NEW YORK 5, N. Y.

*Reg. U. S. Pat. Off.

NICKEL INCO ALLOYS
TRADE MARK

MONEL* • "K"* MONEL • "R"* MONEL • "KR"* MONEL • "S"* MONEL • INCONEL* • NICKEL • "L"* NICKEL • "Z"* NICKEL



CHICAGO DAILY NEWS, Tuesday, March 25, 1947. ★★★ 27

EVERYBODY'S BUSINESS

Rivals Help Firm Get Back on Feet After Fire

BY PHIL S. HANNA.

Those who say there isn't any sentiment in business might consider what sentiment did to help a burned out West Side manufacturer hold his trade and quickly get back into production.

About 4:30 a.m. on Monday, March 3, the Accurate Spring Manufacturing Co., at 3811 W. Lake st., had a real fire. It was called a total loss. The brick walls were left standing but that was about all. All records and office equipment were destroyed with the exception of those in the vault.

PHIL S. HANNA.

The president of the company, F. D. Weber, happened to be in Florida but the vice-president and general manager, A. A. Bonde, was quickly on the job.

* * *

BY NOON OF THE DAY of the fire, with the help of the Illinois Bell Telephone Co. and the Graemere Hotel, five trunk lines were operating at the hotel on the company's regular telephone number. Bonde and his aids were contacting customers all over the country.

Within a few hours after the fire five competitors in Chicago had volunteered to produce springs for the Accurate company. Some offered to use Accurate personnel to give the company full opportunity to meet the particular needs of its customers.

The Galter Manufacturing Co., 711 W. Lake st., one of Accurate's customers and a manufacturer of cameras and lighters, turned over floor space to Accurate for rebuilding tools and permitted Accurate personnel to use its tool-making machinery. Another manufacturer offered the use of brand-new machines.

* * *

A MEETING OF THE Chicago Association of Spring Manufacturers was called to help Accurate get back into production for it was realized how seriously the fire had endangered the close production schedules of the automobile industry, a big user of springs.

On Monday, March 10, seven days after the fire, the Accurate company set up temporary headquarters in a plant at 1474 W. Hubbard st., leased from the Nu-Tone, Inc., manufacturers of chimes. Nu-Tone was moving and Accurate took over an unexpired lease, a number of punch presses and tool room equipment.

On the 10th day after the fire contracts were placed with L. J. Graf Construction Co. to rebuild the factory at 3811 W. Lake st.

* * *

MORE THAN 150 EMPLOYEES had been called back to work. The company's branch plant at Fowler, Indiana, was doing double duty.

"Call us on our new telephone, MONroe 1145," says a letter from President Weber to his customers under date of March 12 (nine days after the fire). "It is likely we can take care of your requirements beginning April 10."

"Why all this co-operation?" I asked of a man who knows the background. "Oh," he replied, "Weber put in 15 years building good will among customers, his competitors and his own employees—and when he got into trouble everybody wanted to help him. It's a Chicago habit, I believe."

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Inc.; Niagara Hudson Po
Sunray Oil Co., and
Corp.

* * *

THE $2.50 par comm
American Airways Cor
$5 par common of Ster
Inc., and Warner Bros.
Inc., the $10 par comm
tional Bisc

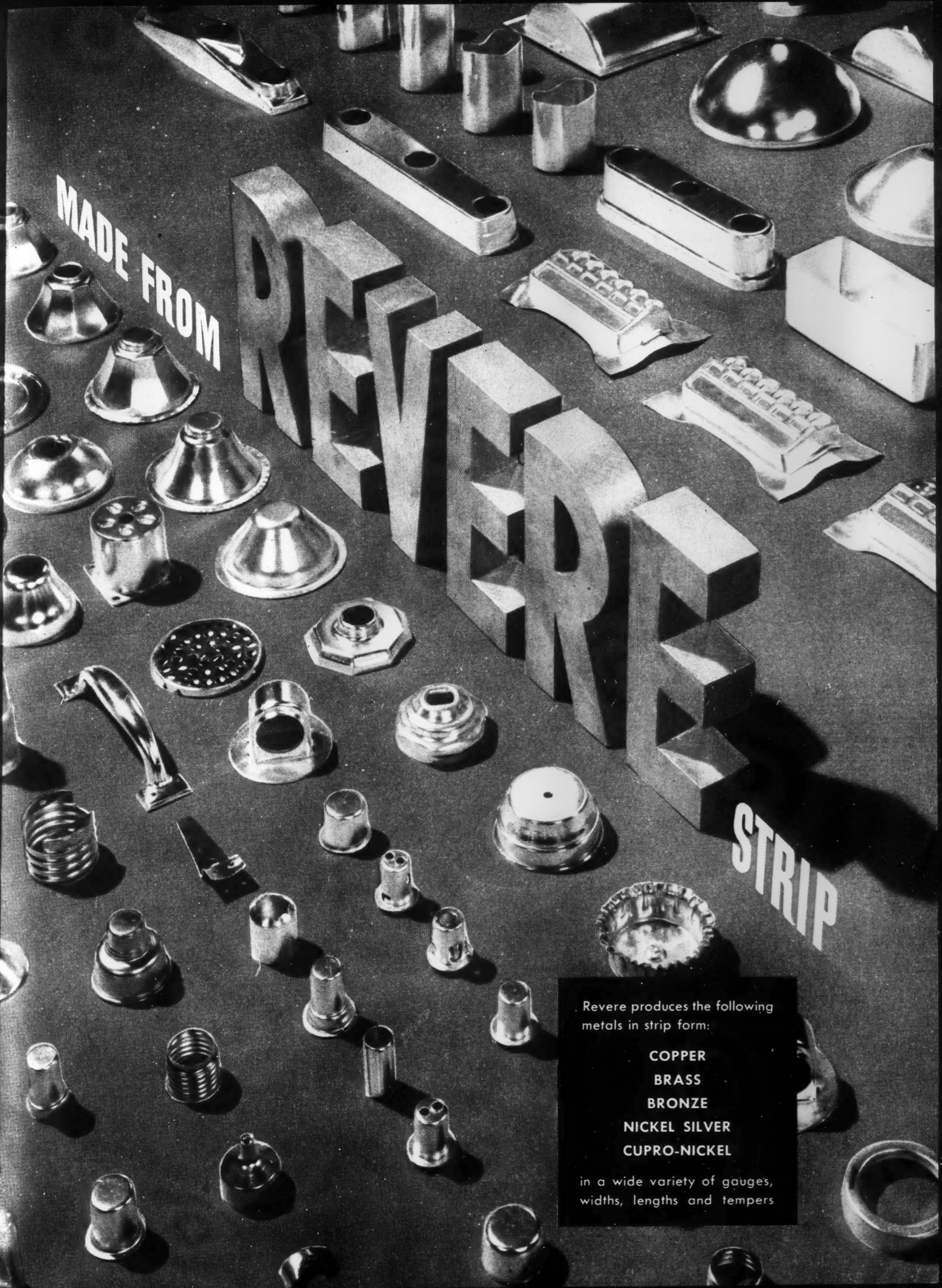
z!

WE would like to use this means to thank those whose cooperation made possible our prompt resumption of production following the fire which destroyed our main plant. We are again able to quote on all types of precision springs and wire forms, and in many cases can promise favorable delivery schedules. When you need springs we will welcome the opportunity to discuss your requirements with you.

ACCURATE SPRING MFG. CO.
1474 W. HUBBARD STREET (Temporary)
CHICAGO 22, ILLINOIS

Accurate Springs

Send for a copy of the Accurate "Handbook of Technical Data on Springs" which contains valuable data on design formulation and load deflection.


MADE FROM
REVERE
STRIP

Revere produces the following metals in strip form:

COPPER
BRASS
BRONZE
NICKEL SILVER
CUPRO-NICKEL

in a wide variety of gauges, widths, lengths and tempers

REVERE
STRIPS and ROLLS for fast, economical fabrication

Revere Metals in strip and roll form are widely used through industry for the manufacture of parts and products by such processes as deep drawing, stamping, punching, spinning, embossing, rolling, etching, soldering, polishing, plating. Special finishes, such as embossed, polished, etc., are available for some alloys and forms. Naturally, the value of such finishes depends upon two main factors: the fabrication processes through which the metal is put in your plant, and the nature of the articles or parts you make. Where suitable, special finishes often reduce costs and improve the beauty, attractiveness or service of the finished product.

BRASS

Probably most manufacturers when they think of non-ferrous strip think of brass, because it is an old and honored metal, corrosion-resistant, and adaptable to a wide range of fabrication conditions, from simple stamping to exceptionally deep drawing, as in cartridge cases. Yet it should be remembered that *brass is not just brass.* There are many different brasses which vary in their composition. In addition, each brass alloy can be had in a variety of physical conditions. By rigid control of processing in the Revere Mills, strict specifications as to temper, hardness, and grain size are met.

COPPER — BRONZE NICKEL SILVER — CUPRO-NICKEL

But in addition to brass strip, Revere also produces strip in copper, bronze, nickel silver, and cupro-nickel. As is the case with brass, each of these is available in a range of compositions and physical characteristics.

GENERAL CONSIDERATIONS

The importance of a careful study of both composition and physical properties cannot be stressed too often, particularly at this time, when certain war developments in the metal industry should be taken into account. It might be, for example, that a difference in alloy, temper, gauge or dimensions would make manufacturing economies possible by increasing the number of draws between anneals.

Worthy of consideration when specifying strip is the question of gauge and width. It is sometimes the case that a reduction in the cost of the material can be achieved by slight changes in gauge and width. To this saving may be added an additional one—reduction in amount of scrap. Though scrap from strip has a high re-sale value, it costs money to segregate and bale it, and any reduction in its amount represents a saving.

Strip is an exceptionally useful form of metal. Revere will gladly cooperate with you in studying the important subject of specification.

On this page you will find technical data on only a few of the Revere Metals produced in strip and other forms as well. If you require further information, get in touch with any Revere Office or distributor.

REVERE
COPPER AND BRASS INCORPORATED
Founded by Paul Revere in 1801
230 Park Avenue, New York 17, New York
Mills: Baltimore, Md.; Chicago, Ill.; Detroit, Mich.; New Bedford, Mass.; Rome, N. Y.—Sales Offices in Principal Cities, Distributors Everywhere.

COMMERCIAL BRONZE, 90%

Alloy no. 120 • (copper 90.0%, zinc 10.0%)

Forms available: sheet, strip, plate, rod, tube, forgings.

General Properties: Revere Commercial Bronze, 90%, has high ductility. Compared to copper, it has higher tensile strength but lower thermal properties.

Typical uses: Commercial Bronze, 90%, is used for costume jewelry, compacts and lipstick cases. Also recommended for forgings, screws, weather stripping and standard hardware.

Working Properties: Cold-working, soldering, polishing — excellent. Hot-working — excellent. Machining—poor. Welding—gas, carbon arc, metal arc.

ASTM specifications: Sheet: B36, B130. Rod: B134

RED-BRASS, 85%

(Rich Low Brass) • Alloy no. 130 • (copper 85.0%, zinc 15.0%)

Forms available: sheet, strip, plate, rod, wire, tube, pipe and lockseam tubing.

General Properties: Revere Red-Brass, 85%, has higher strength and greater ductility than copper, and its excellent corrosion resistance often exceeds that of copper, as in salt water.

Typical uses: Red-Brass, 85%, is recommended for jewelry, name plates, badges, tags, dials, hardware, etched parts. For tubing and pipe for oil and utility fields and plumbing. Also for automobile radiators, bellows and flexible tubing.

Working Properties: Cold-working, soldering, polishing — excellent. Hot-working — good. Machining—fair. Welding—gas, carbon arc, metal arc, spot and seam welding for thin gauge.

ASTM specifications: Sheet: B36, B111, B135. Rod: B134. Tube: B43.

SEVENTY-THIRTY BRASS

(Cartridge Brass) • Alloy no. 160 • (copper 70.0%, zinc 30.0%)

Forms available: sheet, strip, tube, rod, rectangular bar and lockseam tubing.

General Properties: Revere Seventy-Thirty Brass has the best combination of ductility and strength of all the brasses and accordingly has superior cold-working properties.

Typical uses: Seventy-Thirty Brass is recommended for cartridge cases, ammunition components and for any difficult deep drawing, stamping or spinning job.

Working Properties: Cold-working, soldering, polishing — excellent. Hot-working — good. Machining—fair. Welding—gas, carbon arc, metal arc, spot and seam welding for thin gauge.

ASTM specifications: Sheet: B19, B36. Tube: B135. Rod: B134.

YELLOW BRASS

Alloy no. 170 • (copper 66.0%, zinc 34.0%)

Forms available: sheet, strip, rod, wire, and lockseam tubing.

General Properties: Revere Yellow Brass possesses excellent cold-working properties with good corrosion resistance. Mechanical properties and corrosion resistance are similar to those of alloys no. 160 and no. 165.

Typical uses: Yellow Brass is recommended for pins, rivets, eyelets, auto radiator cores, heating units, lamp bodies and reflectors, electrical sockets, and drawn shapes. Also for deep drawing, stamping, spinning, etching and rolling for practically all fabricating processes.

Working Properties: Cold-working, soldering, polishing—excellent. Machining—fair. Welding—gas, carbon arc, metal arc, spot and seam welding for thin gauge.

ASTM specifications: Sheet: B36.

PHOSPHOR BRONZE, 5% (A)

Alloy no. 308 • (copper 95.0%, phosphorus 0.05%, tin 5.0%)

Forms available: sheet, strip, rod.

General Properties: Revere Phosphor Bronze, grade A, possesses high tensile strength, high resistance to corrosion and fatigue and has a low friction coefficient. It is also highly resistant to season cracking.

Typical uses: Revere Phosphor Bronze, grade A, is used for springs, diaphragms, bellows, lock washers, cotter pins, fuse clips, clutch discs, screw machine stock, perforated sheets, etc.

Working Properties: Cold-working, soldering, polishing — excellent. Hot-working — poor. Machining—fair. Welding—gas, carbon arc, metal arc, spot and seam welding for thin gauge.

ASTM specifications: Sheet: B100, B103. Rod: B139.

NICKEL SILVER, 18% (A)

Alloy no. 533 • (copper 65.5%, nickel 18.0%, zinc 16.5%)

Forms available: sheet, strip, lockseam tubing.

General Properties: Revere Nickel Silver has high resistance to corrosion and tarnish. It is also malleable and ductile.

Typical uses: Nickel Silver is recommended for marine and automotive trim, hardware, architectural panels and extruded shapes, lighting, electrical and plumbing fixtures, various equipment of the process industries, tableware, jewelry, stamping and etching.

Working Properties: Cold-working, soldering, polishing—excellent. Hot-working, machining—fair. Welding—gas, carbon arc, metal arc, spot and seam welding for thin gauge.

ASTM specifications: Sheet: B122. Rod: B151.

NICKEL SILVER, 18% (B)

Alloy no. 555 • (copper 55.0%, nickel 18.0%, zinc 27.0%)

Forms available: strip, lockseam tubing.

General Properties: Revere Nickel Silver (spring stock) possesses high physical properties, high resistance to corrosion and tarnish and high fatigue strength.

Typical uses: Nickel Silver (spring stock) is recommended especially for springs, also for marine and automotive trim, hardware, architectural panels and extruded shapes, lighting, electrical and plumbing fixtures, various equipment of the process industries, tableware, jewelry, stamping and etching.

Working Properties: Cold-working, soldering, polishing—excellent. Hot-working, machining—fair. Welding—gas, carbon arc, metal arc, spot and seam welding for thin gauge.

ASTM specifications: Sheet: B122.

HERCULOY

(Silicon Bronze)

Alloy	Copper	Silicon	Manganese
420	96.0%	3.0%	1.0%
421	98.00%	1.75%	0.25%

Forms available: sheet, strip, plate, rod, wire, tube, forgings.

General Properties: Herculoy has excellent mechanical properties. The strength of Herculoy is comparable to that of low and medium carbon steel. Its resistance to corrosion is similar to that of copper. These alloys are non-magnetic and gold colored.

Typical uses: Herculoy is recommended for tanks, pressure vessels (unfired pressure vessels codes), vats, baskets, hardware, bolts, screws, lag screws, cotter pins, washers, turnbuckles, marine construction, shafting, plates, screens, filters, ducts, weatherstrips, springs, forgings, electrical conduit.

Working Properties: Cold-working, soldering—excellent. Hot-working—good. Machining, polishing—fair. Welding—gas, carbon arc, metal arc, spot and seam welding for narrow gauge.

ASTM specifications: Sheet: B96, B97, B100. Rod: B98, B124.

Nothing pleases Revere more than to be able to sit down with a customer and discuss fabrication methods and end uses. Such friendly collaboration often has resulted in increased production, lower costs, an improved product, or all three. In one case, substitution of leaded brass for high brass was suggested, for greater ease in blanking and to reduce the need for dressing down with a file after assembly. In another, a slight change in gauge reduced material cost. In still another, a different temper eliminated one anneal. The Revere Technical Advisory Service is at your command.

PROVED USEFULNESS

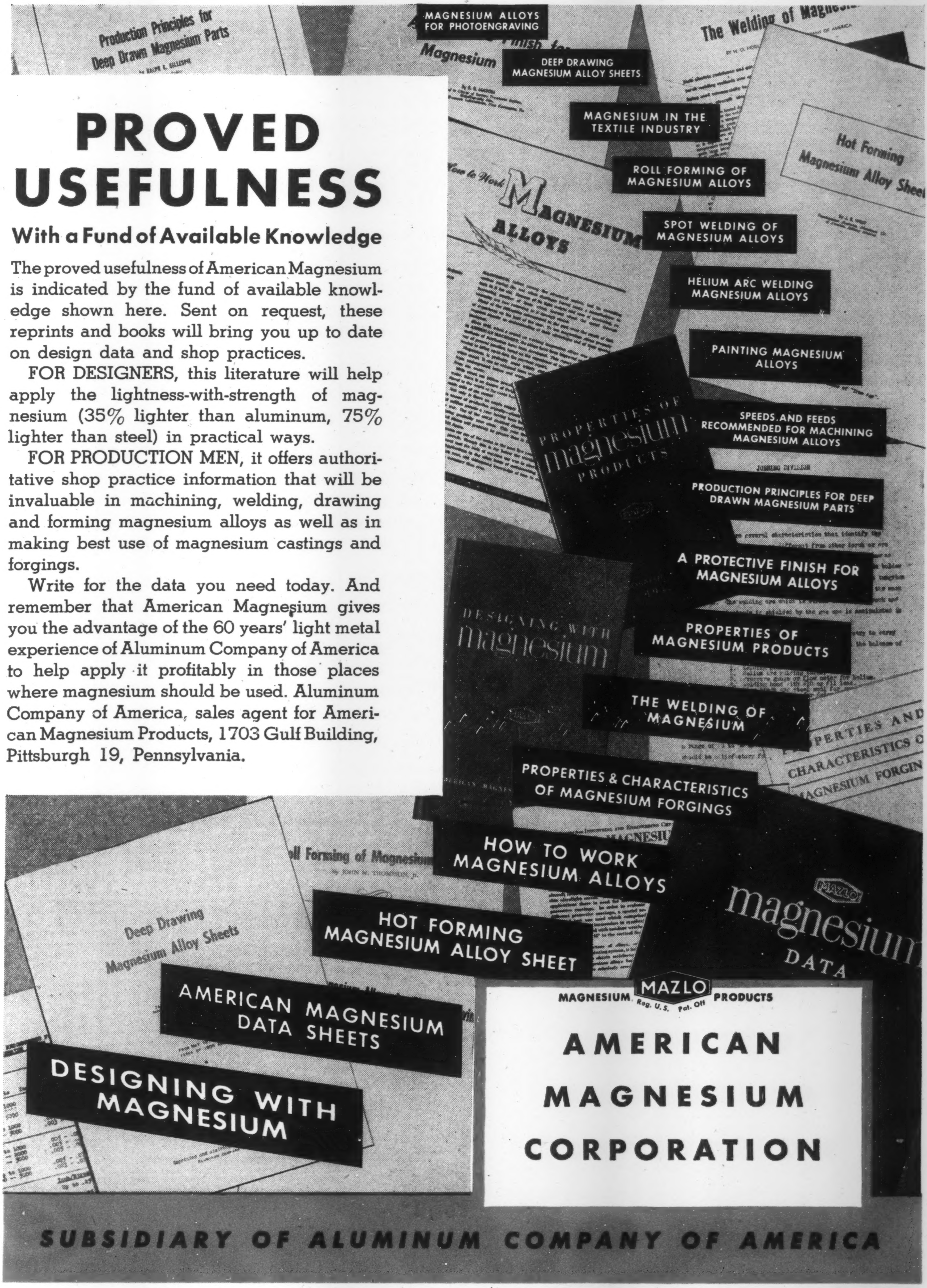
With a Fund of Available Knowledge

The proved usefulness of American Magnesium is indicated by the fund of available knowledge shown here. Sent on request, these reprints and books will bring you up to date on design data and shop practices.

FOR DESIGNERS, this literature will help apply the lightness-with-strength of magnesium (35% lighter than aluminum, 75% lighter than steel) in practical ways.

FOR PRODUCTION MEN, it offers authoritative shop practice information that will be invaluable in machining, welding, drawing and forming magnesium alloys as well as in making best use of magnesium castings and forgings.

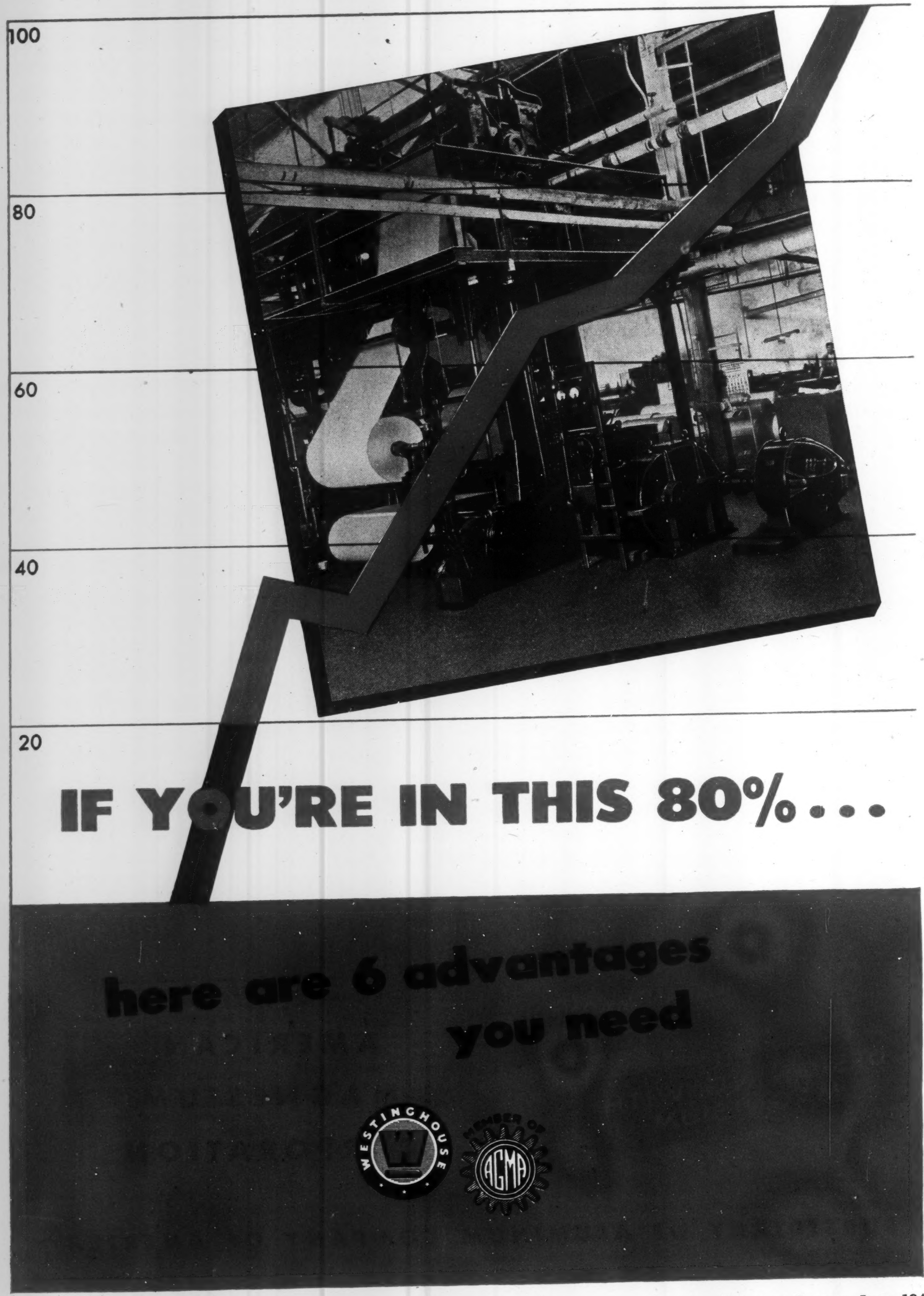
Write for the data you need today. And remember that American Magnesium gives you the advantage of the 60 years' light metal experience of Aluminum Company of America to help apply it profitably in those places where magnesium should be used. Aluminum Company of America, sales agent for American Magnesium Products, 1703 Gulf Building, Pittsburgh 19, Pennsylvania.


MAGNESIUM ALLOYS FOR PHOTOENGRAVING
DEEP DRAWING MAGNESIUM ALLOY SHEETS
MAGNESIUM IN THE TEXTILE INDUSTRY
ROLL FORMING OF MAGNESIUM ALLOYS
SPOT WELDING OF MAGNESIUM ALLOYS
HELIUM ARC WELDING MAGNESIUM ALLOYS
PAINTING MAGNESIUM ALLOYS
SPEEDS AND FEEDS RECOMMENDED FOR MACHINING MAGNESIUM ALLOYS
PRODUCTION PRINCIPLES FOR DEEP DRAWN MAGNESIUM PARTS
A PROTECTIVE FINISH FOR MAGNESIUM ALLOYS
PROPERTIES OF MAGNESIUM PRODUCTS
THE WELDING OF MAGNESIUM
PROPERTIES & CHARACTERISTICS OF MAGNESIUM FORGINGS
HOW TO WORK MAGNESIUM ALLOYS
HOT FORMING MAGNESIUM ALLOY SHEET
AMERICAN MAGNESIUM DATA SHEETS
DESIGNING WITH MAGNESIUM
Production Principles for Deep Drawn Magnesium Parts
The Welding of Magnesium
Hot Forming Magnesium Alloy Sheet
How to Work Magnesium Alloys
Properties of Magnesium Products
Designing with Magnesium
Properties and Characteristics of Magnesium Forgings
Roll Forming of Magnesium
Deep Drawing Magnesium Alloy Sheets
Mazlo magnesium Data

MAGNESIUM MAZLO Reg. U. S. Pat. Off PRODUCTS

AMERICAN MAGNESIUM CORPORATION

SUBSIDIARY OF ALUMINUM COMPANY OF AMERICA

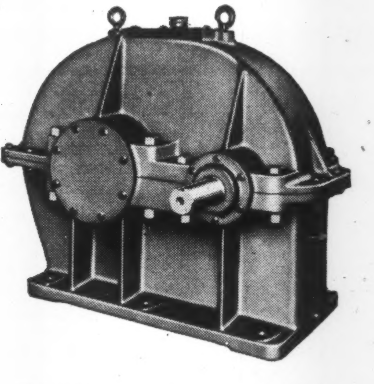

100
80
60
40
20

IF YOU'RE IN THIS 80%...

here are 6 advantages you need

WESTINGHOUSE

MEMBER OF AGMA



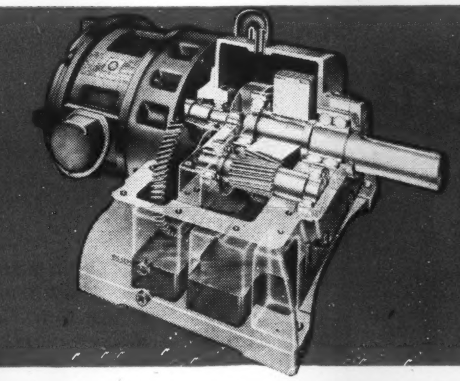
This Type SH speed reducer is a single-reduction unit which is furnished in thirteen standard ratios in each of twelve sizes. The Type DH speed reducer, which is a double-reduction unit, is offered in fifteen standard ratios in each of twelve sizes.

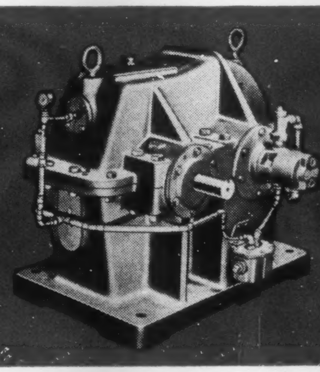
Since 80% of all machines run slower than their prime movers, you'll want to capitalize on the six benefits of the packaged designs in Westinghouse speed reducers:

1. Higher power efficiency (one plant boosted it from 80.9% to 85.4%).
2. Less servicing . . . only semiannual lubrication needed.
3. Maintain positive alignment of drive and driven machine.
4. Long service life through single helical gearing heat-treated by exclusive Westinghouse BPT process.
5. Minimum power loss with antifriction bearings.
6. Precision operation from hob-cut gears.

In addition, you get undivided responsibility with motor and gears supplied by one manufacturer. You have your choice of twenty-four sizes of Westinghouse speed reducers for drives up to 1,000 hp—Types SH and DH—with speed reduction ratios of 2.82 to 70.5.

Ask your nearest Westinghouse office today to show you how to get the best in speed reduction for your plant with Westinghouse speed reduction matched unit drives. Westinghouse Electric Corporation, P. O. Box 868, Pittsburgh 30, Penna. J-07253





FOR DRIVES FROM 1 TO 75 HP
CHOOSE GEARMOTORS

For all types of drives, Westinghouse gearmotors offer peak performance in modern speed reduction. Easy to install, service and adapt to varied conditions. Three types—A, C, and E—supply output speeds from 1,450 to 16.5 rpm, all available with single-phase, polyphase, or d-c motors.

HANDLE ALL YOUR HIGH-SPEED JOBS
WITH THESE MATCHED-UNIT DRIVES

Now you can handle all your high-speed drives with these Westinghouse Type SU speed increasers for jobs up to 2,000 hp and 9,000 rpm. Units are available in 30 sizes—with gear ratios of 1.25 to 3.25 up to 2 to 12.

Here's a complete picture story **of industrial geared drives and their uses in every industry. Ask for your copy of B-3730 today, on your business letterhead, please.**

Westinghouse
PLANTS IN 25 CITIES . . . OFFICES EVERYWHERE

4 out of 5 drives need speed reduction

Why most piping equipment "Specs" read: CRANE or Equal

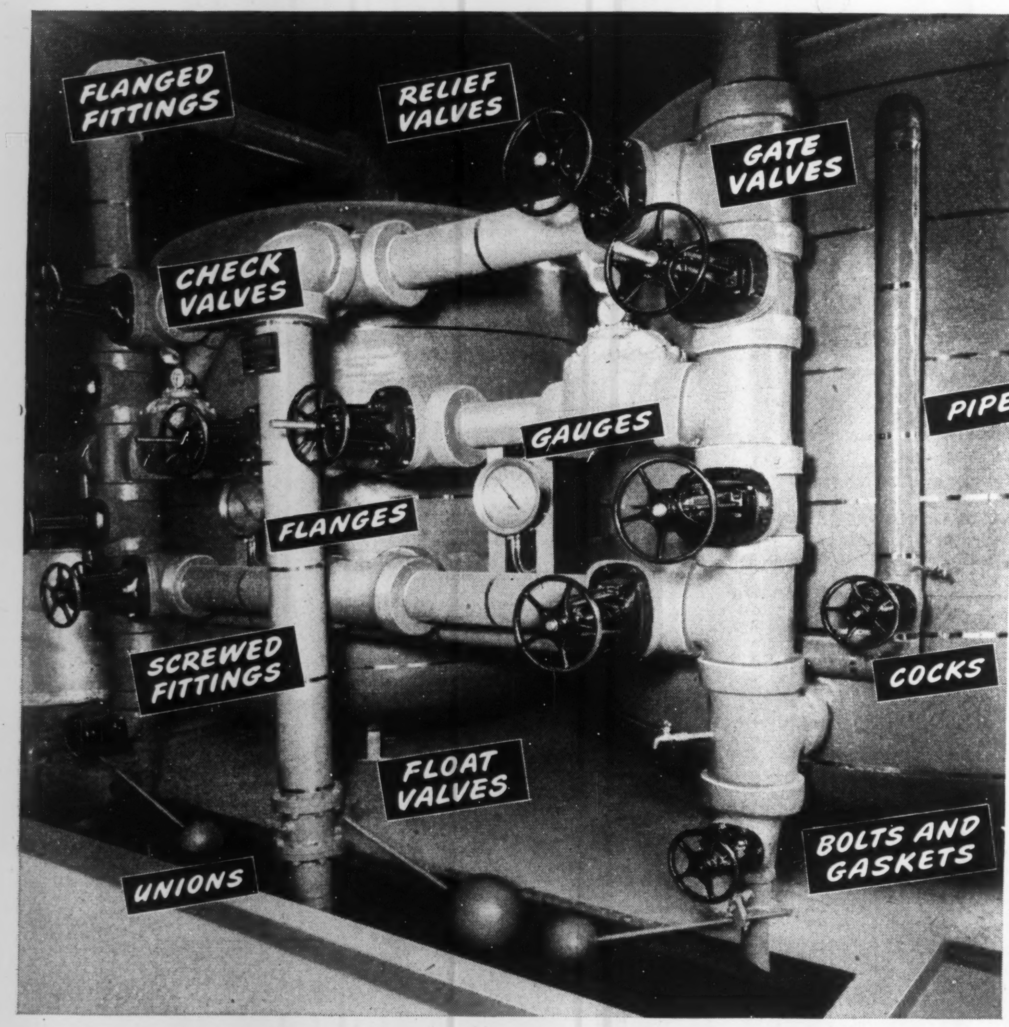
When the best is also the easiest to specify, it's no wonder that *"Crane or equal"* appears on most piping specifications.

The completeness of the Crane line puts everything you need in brass, iron, steel and alloy piping materials at your finger tips . . . valves, fittings, piping accessories, and pipe—all from one convenient source.

Dealing with Crane assures single responsibility and smooth procedures all down the line, wherever piping equipment is involved—in specifying, buying, storekeeping, and final assembly. And the satisfaction of your customers will be complete when they see that the piping equipment is Crane . . . for they know that there is none more dependable.

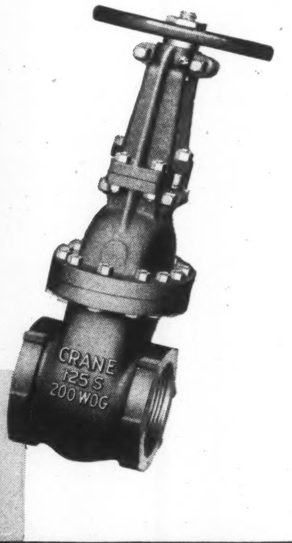
ONE
SOURCE OF SUPPLY
RESPONSIBILITY
STANDARD OF QUALITY

CRANE CO., *General Offices:* 836 S. Michigan Ave., Chicago 5, Ill.
Branches and Wholesalers Serving All Industrial Areas



Refinite Water Treating Unit equipped by Crane . . . product of The Refinite Corporation.

(Below)
FACTS YOU SHOULD KNOW *about Crane Standard Iron Body Wedge Gate Valves: Improved design features extreme compactness with increased resistance to service stresses. Straight-through ports give streamline flow. Interior refinements insure true, tight seating, smooth operation. Fully accessible for servicing. In all patterns and sizes; for steam pressures up to 125 lbs.; for cold pressures up to 200 lbs. See your Crane Catalog.*



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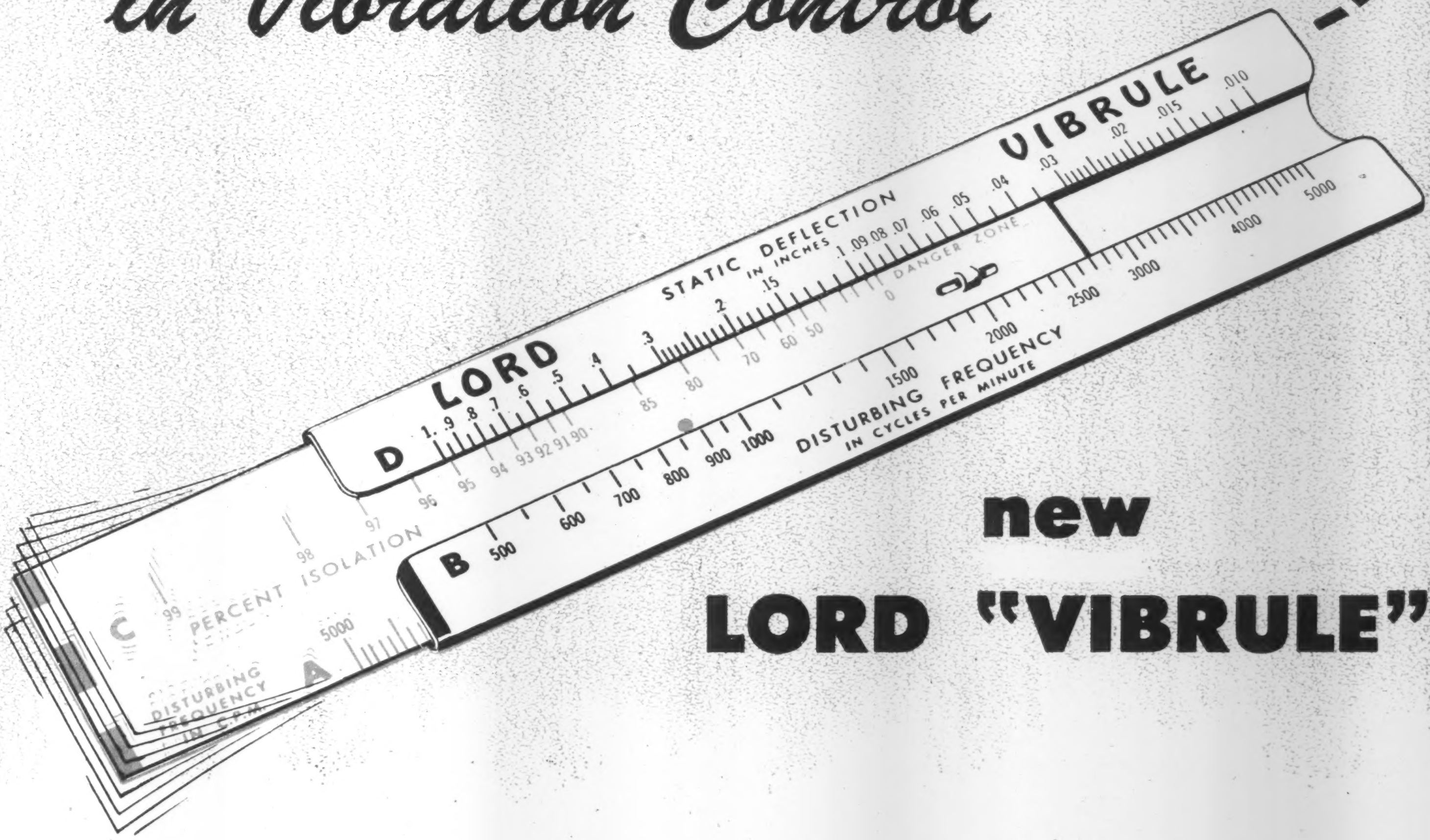
VALVES • FITTINGS
PIPE • PLUMBING
AND HEATING

CRANE

FOR EVERY PIPING SYSTEM

Another LORD *Service in Vibration Control*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LORD
STATIC DEFLECTION IN INCHES
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DANGER ZONE
0 50 60 70 80 85 90 91 92 93 94 95 96 97 98 99
PERCENT ISOLATION
D
B
500 600 700 800 900 1000 1500 2000 2500 3000 4000 5000
DISTURBING FREQUENCY IN CYCLES PER MINUTE
C
A
5000
DISTURBING FREQUENCY IN C.P.M.

new LORD "VIBRULE"

. . . measures vibration quickly—easily!

THE new LORD VIBRULE . . . another LORD service in vibration control . . . provides a quick, simple means of measuring vibration in equipment or machines which you build or use. Does the work of expensive, complicated instruments . . . easy to use . . . gives approximate, practical readings.

When held against the vibrating surface, the LORD VIBRULE gives direct readings of the Disturbing Frequency in cycles per minute; the Static Deflection in inches which must be provided to give the desired Percentage of Isolation; and the Total Amplitude of movement in inches.

The LORD VIBRULE will be sent free to anyone who is responsible for the efficient design or operation of products, or production machinery. Write for your LORD VIBRULE, or use the coupon.

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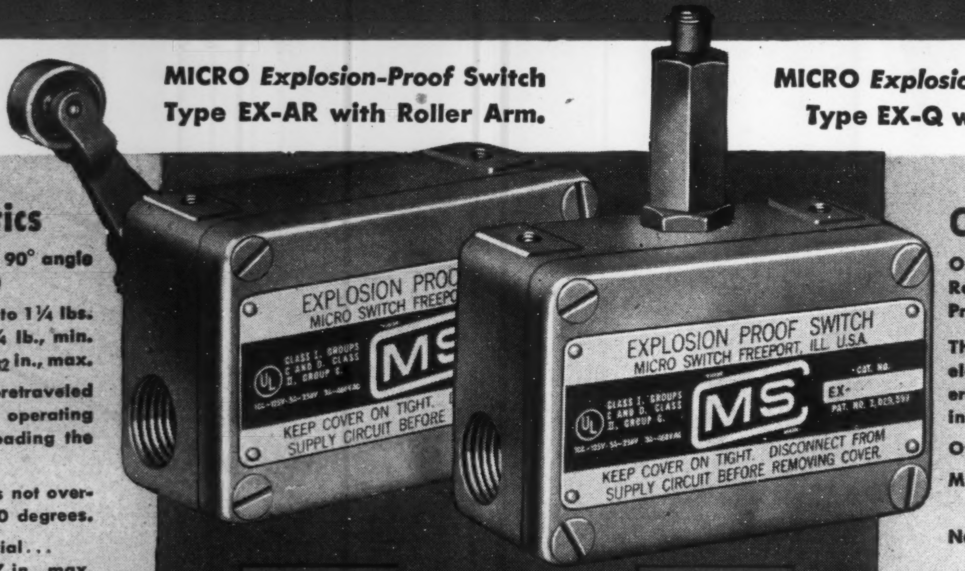
a MICRO *Explosion-Proof* Switch


EXPLOSION PROOF SWITCH
MICRO SWITCH FREEPORT, ILL. U.S.A.
MS
EX-
KEEP COVER ON TIGHT. DISCONNECT FROM SUPPLY CIRCUIT BEFORE REMOVING COVER.

MICRO *Explosion-Proof* Switch
Type EX-AR with Roller Arm.

MICRO *Explosion-Proof* Switch
Type EX-Q with Plunger.

Characteristics

(at the roller and at 90° angle with arm)

Operating Force. ½ to 1¼ lbs.
Release Force. . . . ¼ lb., min.
Pretravel. . . . . 7/32 in., max.

The roller may be pretraveled to 1/32 inch from the operating point without preloading the Basic Switch.

Overtravel. . . . Does not overtravel more than 90 degrees.

Movement Differential . . .
. . . . 0.007 in., max.

Net Weight. . . . . 2.5 lbs.

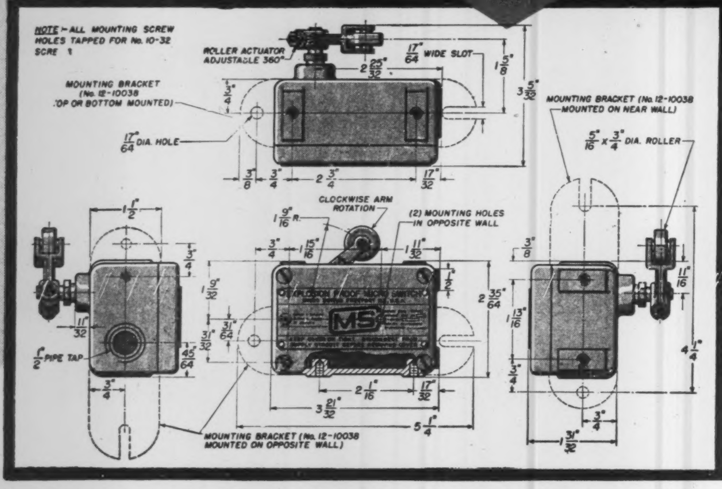
Characteristics

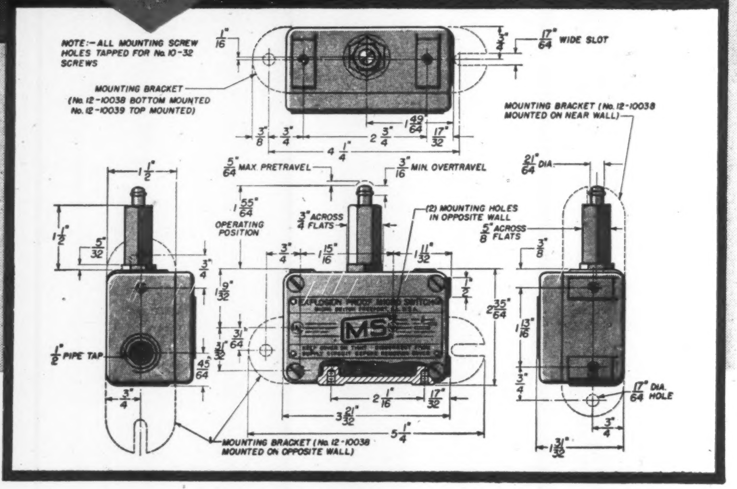
Operating Force. . 3 lbs., max.
Release Force. . . . ¾ lb., min.
Pretravel. . . . . . . 5/64 in., max.

The plunger may be pretraveled to 0.020 in. from the operating point without preloading the Basic Switch.

Overtravel. . . . . 3/16 in., min.
Movement Differential . . .
. . . . 0.004 in., max.

Net Weight. . . . . 2.4 lbs.


NOTE—ALL MOUNTING SCREW HOLES TAPPED FOR No. 10-32 SCRE
ROLLER ACTUATOR ADJUSTABLE 360°
MOUNTING BRACKET (No. 12-10038 TOP OR BOTTOM MOUNTED)
17/64 WIDE SLOT
17/64 DIA. HOLE
MOUNTING BRACKET (No. 12-10038 MOUNTED ON NEAR WALL)
5/16 x 3/4 DIA. ROLLER
CLOCKWISE ARM ROTATION
(2) MOUNTING HOLES IN OPPOSITE WALL
1/2 PIPE TAP
MOUNTING BRACKET (No. 12-10038 MOUNTED ON OPPOSITE WALL)


NOTE:—ALL MOUNTING SCREW HOLES TAPPED FOR No. 10-32 SCREWS
MOUNTING BRACKET (No. 12-10038 BOTTOM MOUNTED No. 12-10039 TOP MOUNTED)
17/64 WIDE SLOT
MOUNTING BRACKET (No. 12-10038 MOUNTED ON NEAR WALL)
5/64 MAX. PRETRAVEL
3/16 MIN. OVERTRAVEL
OPERATING POSITION
3/4 ACROSS FLATS
(2) MOUNTING HOLES IN OPPOSITE WALL
5/8 ACROSS FLATS
21/64 DIA.
17/64 DIA. HOLE
1/2 PIPE TAP
MOUNTING BRACKET (No. 12-10038 MOUNTED ON OPPOSITE WALL)

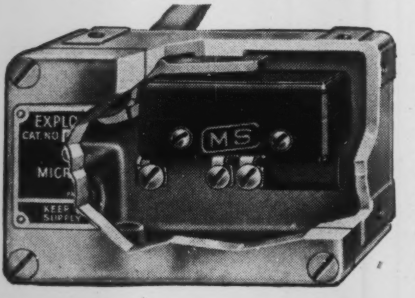
The above drawing shows, in dotted outline, the application of the No. 12-10038 mounting bracket and indicates the relationship of its mounting holes to the tapped mounting holes in the switch case. This mounting bracket and the screws for attaching it to the housing are furnished with each switch.

The mounting bracket may be used on any of the four mounting faces or the switch may be used without the bracket.

The above drawing shows, in dotted outline, the application of the No. 12-10038 mounting bracket and indicates the relationship of its mounting holes to the tapped mounting holes in the switch case. This mounting bracket and the screws for attaching it to the housing are furnished with each switch. This bracket may be used on the end, back, or bottom of the housing.

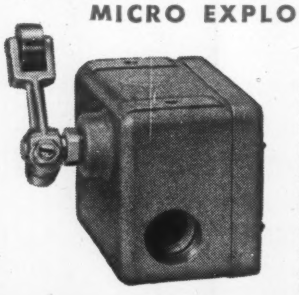
Mounting bracket No. 12-10039, which must be purchased separately, is available for mounting from the plunger face of the housing.

FEATURES OF EXPLOSION-PROOF SWITCHES


EXPLO
CAT. NO
MICR
MS
KEEP
SUPPLY

The housing walls are tested under hydraulic pressure to withstand four times the pressure observed on explosion tests. While the assembly is not entirely sealed, the path between the cover and the case and along the actuator bearings is of sufficient length that hot gases of an explosion within the housing will be cooled below the kindling temperature before they reach an outside explosive atmosphere.

ADJUSTABLE ROLLER ARM TYPE EX-AR
MICRO EXPLOSION-PROOF SWITCH



The roller arm actuator is adjustable to any point in 360 degrees. 90 degrees overtravel is also available. To adjust the operating position of the roller assembly it is only necessary to loosen the locking nut and turn the adjusting screw, to locate the arm at the desired position. The roller is of nonsparking material and rides on an oil-impregnated bronze bearing.

MADE WITH THE "*KNOW-HOW*" BEHIND MILLIONS OF PRECISION SWITCHES

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. . Will Protect Your Equipment in an Explosive Atmosphere

For equipment to be used near paint, varnish, starch, pyroxylin, chemicals, flour, oil or other explosive materials

● The MICRO Precision Switch line offers an Explosion-Proof Switch for use in explosive atmospheres. These switches have closely held operating points and small movement differentials, and are used as limit, safety, control and interlock switches on equipment used in hazardous atmospheres around paint, varnish, starch, pyroxylin and chemical factories, flour mills and oil refineries. They fulfill requirements where unprotected switches are not acceptable.

The explosion-proof switch with roller arm actuator is designed to operate by fast cams and slides. The roller arm actuator is die cast and secured to the operating shaft by an adjusting screw, through which 360 degrees of adjustment is available. The roller is nonsparking alloy of high concentricity and has an oil-impregnated bronze bearing. Housing walls are tested under hydraulic pressure to withstand four times the pressure observed on explosion tests.

MICRO Explosion-Proof Switches are Underwriters' approved for hazardous atmospheres Class 1, Groups C and D and Class II, Group G. This includes vapors of ethyl ether, gasoline, petroleum, alcohol, acetone, lacquer solvent, natural gas, and atmospheres charged with grain dust.

The complete line of MICRO Precision Switches is made with 3,365 varied characteristics of housings, actuations, shapes, sizes and electrical characteristics. They provide the solution to thousands of electrical switching problems. They add safety features to equipment and act as interlock and limit switches. When used to make equipment automatic they save time and step up production.

For complete details covering MICRO Precision Switches contact the nearest branch or sales representative as listed below.

This MICRO Precision Switch is Used Where Subjected to splash of oil, water, coolant or similar liquids

On equipment not subjected to immersion but exposed to splashing of liquids the MICRO Splash-Proof Switch solves an electrical switching problem. This switch is available with plunger actuator and with roller arm actuator as shown, which can be operated by fast cams and slides. This switch in turn serves as an interlock, limit or safety in the same manner as other MICRO Precision Switches but is protected against the splash of liquids. If you have an electrical switching problem where liquids or coolants are present it will pay to consult a MICRO engineer regarding the MICRO Splash-Proof Switch.

CHARACTERISTICS

	Roller Arm (OP-AR)	*Plunger (OP-Q)*
Operating Force	½ to 1¼ lbs.	3 lbs., max.
Release Force	¼ lb., min.	¾ lb., min.
Pretravel	7/32 in., max.	5/64 in., max.
Overtravel	not more than 90°	3/16 in., min.
Movement Differential	0.007 in., max.	0.004 in., max.
Net Weight	2.5 lbs.	2.4 lbs.

MICRO SPLASH-PROOF SWITCH

SPLASH PROOF SWITCH
MS
MICRO SWITCH FREEPORT, ILL. U.S.A.

TYPE OP-AR

MICRO *Precision Switches*

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A DIVISION OF FIRST INDUSTRIAL CORPORATION
FREEPORT, ILLINOIS, U.S.A.

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And when you order from The Timken Roller Bearing Company, you can be sure of the same extreme hardenability, high tensile strength, excellent machinability and high fatigue strength in each shipment. Our 52100 seamless steel tubes are produced under the precise control of one organization—from melt shop through finished tube inspection.

Be sure your name is added to our regular 52100 tubing mill stock mailing list. We'll send you a complete list of immediately available sizes and finishes.

And for dependable quality and quick delivery, mail, wire, or telephone your order for 52100 seamless steel tubes to Steel and Tube Division, The Timken Roller Bearing Company, Canton 6, Ohio.

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Fine Alloy
STEEL
and Seamless Tubes

YEARS AHEAD—THROUGH EXPERIENCE AND RESEARCH

Specialists in alloy steel—including hot rolled and cold finished alloy steel bars—a complete range of stainless, graphitic and standard tool analyses—and alloy and stainless seamless steel tubing.

Sheave to Transmit 1400 Horsepower . . .

. . . or a Belt for a 1/4 hp Compressor!

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Back of every *Texrope* installation — from fractional horse power V-belts that manufacturers put on washers, air-compressors or water systems—to the biggest V-belt drives ever designed and successfully applied—stands the finest V-belt engineering talent in the world.

There's no substitute for this vast experience and tremendous fund of knowledge. It is reflected in every *Texrope* product.

What do *you* need . . . a few V-belts and sheaves — or a daring new application of the multiple V-belt principle? Call on the *Texrope* line! Equipment and engineering help are as close as your nearest A-C sales office or dealer. ALLIS-CHALMERS, MILWAUKEE.

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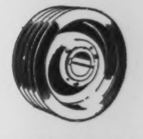
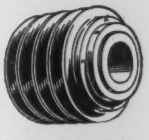
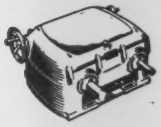
"Super 7" V-BELTS
Five Types — Sizes to suit every power transmission job.



Texsteel, Texdrive, "Magic-Grip"
— sheaves in a full range of sizes, grooves.



"Vari-Pitch" SHEAVES
Exact variations in speed, stationery or motion control.



SPEED CHANGERS
Speed variations up to 375% at the turn of a crank.

ENGINEERING
Finest V-Belt engineering talent in the world—at your call.

TEXROPE "Super 7" V-Belts result from the cooperative research of two great companies — Allis-Chalmers and B. F. Goodrich. They are sold only by A-C.

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One of the Big 3 in Electric Power Equipment — Biggest of All in Range of Industrial Products

AC
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A CENTURY OF SERVICE to Industry THAT MADE America Great

Trentweld
STAINLESS STEEL TUBING
Resistant to Corrosion
Resistant to High Pressure
Resistant to High Temperature
Favorable Appearance
Great Strength + Lightweight
right down the line with the qualities you want in the sizes that you need

IN your continuing effort to improve operating performance, you'll want to keep in mind the inherent advantages that Trentweld tubing offers in making machines better—more lasting—and more useful.

For example, this thin-walled or thick-walled tubing is specifically engineered to the functional character of the job it is intended for. Made by a singular automatic method of rolling and welding, this new, advanced tubing, in thin-walled or thick-walled form, is unusually uniform in composition and structure. Pickling and annealing operations are precisely controlled and adjusted to the end application of the tubing. The net result is a fine-grained metal—stainless steel or Inconel—so homogeneous, so completely free from inclusions, so especially treated for severe industrial requirements, that it has far more than an ordinary capacity for service. Any range of finish, interior or exterior, can be applied—a factor all to the good where surface appearance is important.

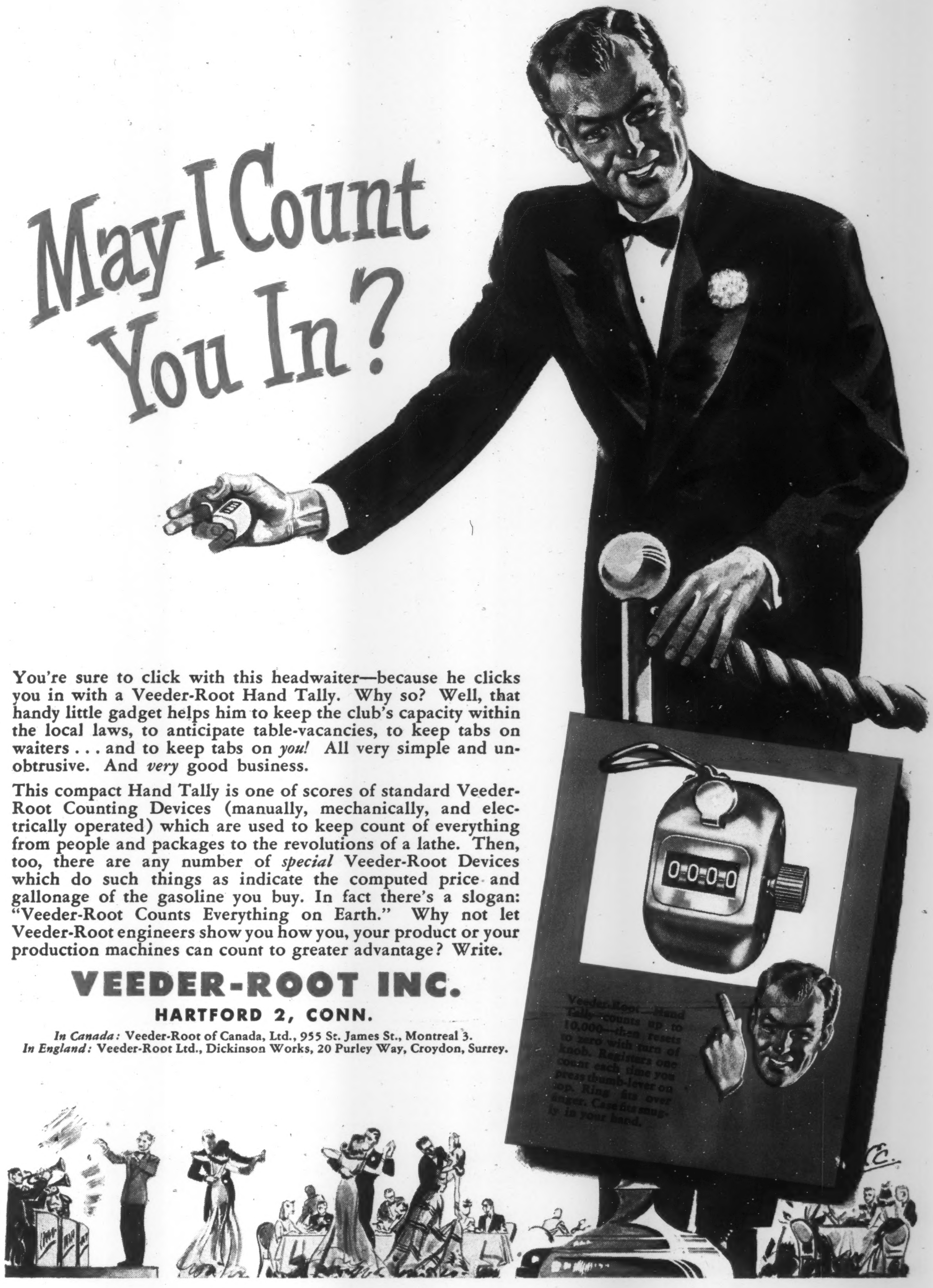
For these reasons and many more, Trentweld tube, in diameters from 1/8" to 24", is being used today by many top-ranking American manufacturers. Feel free to call on Trentweld engineers—as others have—to put a shoulder to the wheel on any application you have in mind. Draw on their wide experience without obligation. Address—Department 21 or write for the Trentweld Data Bulletin.

TRENTWELD STAINLESS STEEL TUBES

Sales Office—664 N. Michigan Avenue, Chicago 11, Illinois

TRENT TUBE MFG. CO.

Mill at East Troy, Wisconsin


May I Count You In?
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Veeder-Root—Hand Tally—counts up to 10,000—then resets to zero with turn of knob. Registers one count each time you press thumb-lever on top. Ring fits over finger. Case fits snugly in your hand.

You're sure to click with this headwaiter—because he clicks you in with a Veeder-Root Hand Tally. Why so? Well, that handy little gadget helps him to keep the club's capacity within the local laws, to anticipate table-vacancies, to keep tabs on waiters . . . and to keep tabs on *you!* All very simple and unobtrusive. And *very* good business.

This compact Hand Tally is one of scores of standard Veeder-Root Counting Devices (manually, mechanically, and electrically operated) which are used to keep count of everything from people and packages to the revolutions of a lathe. Then, too, there are any number of *special* Veeder-Root Devices which do such things as indicate the computed price and gallonage of the gasoline you buy. In fact there's a slogan: "Veeder-Root Counts Everything on Earth." Why not let Veeder-Root engineers show you how you, your product or your production machines can count to greater advantage? Write.

VEEDER-ROOT INC.

HARTFORD 2, CONN.

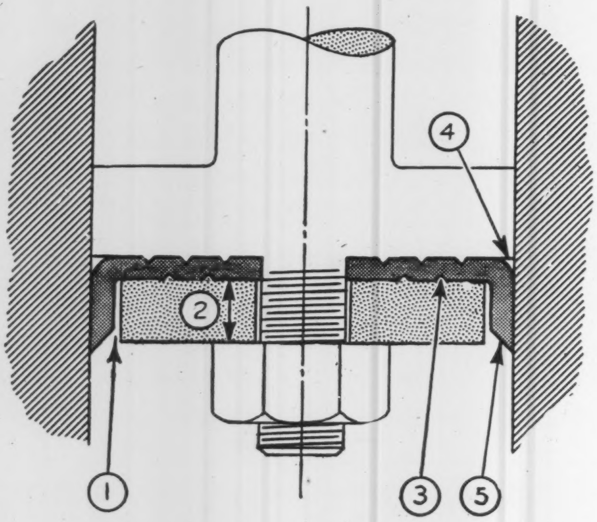
In Canada: Veeder-Root of Canada, Ltd., 955 St. James St., Montreal 3.
In England: Veeder-Root Ltd., Dickinson Works, 20 Purley Way, Croydon, Surrey.

. . . *and on Page 5*

of the Alexander LEATHER Packing Guide . . . you will find

CUP PACKINGS

—with a very interesting and informative description and story about this much-used type of packing. And there are complete details concerning this mechanical drawing which shows a typical cup assembly.



The Alexander Guide is truly a guide on Leather Packings and their use. It tells about Alexander special leather impregnations which are designed to withstand the action of air, oil, water, and other mediums at any required pressure.

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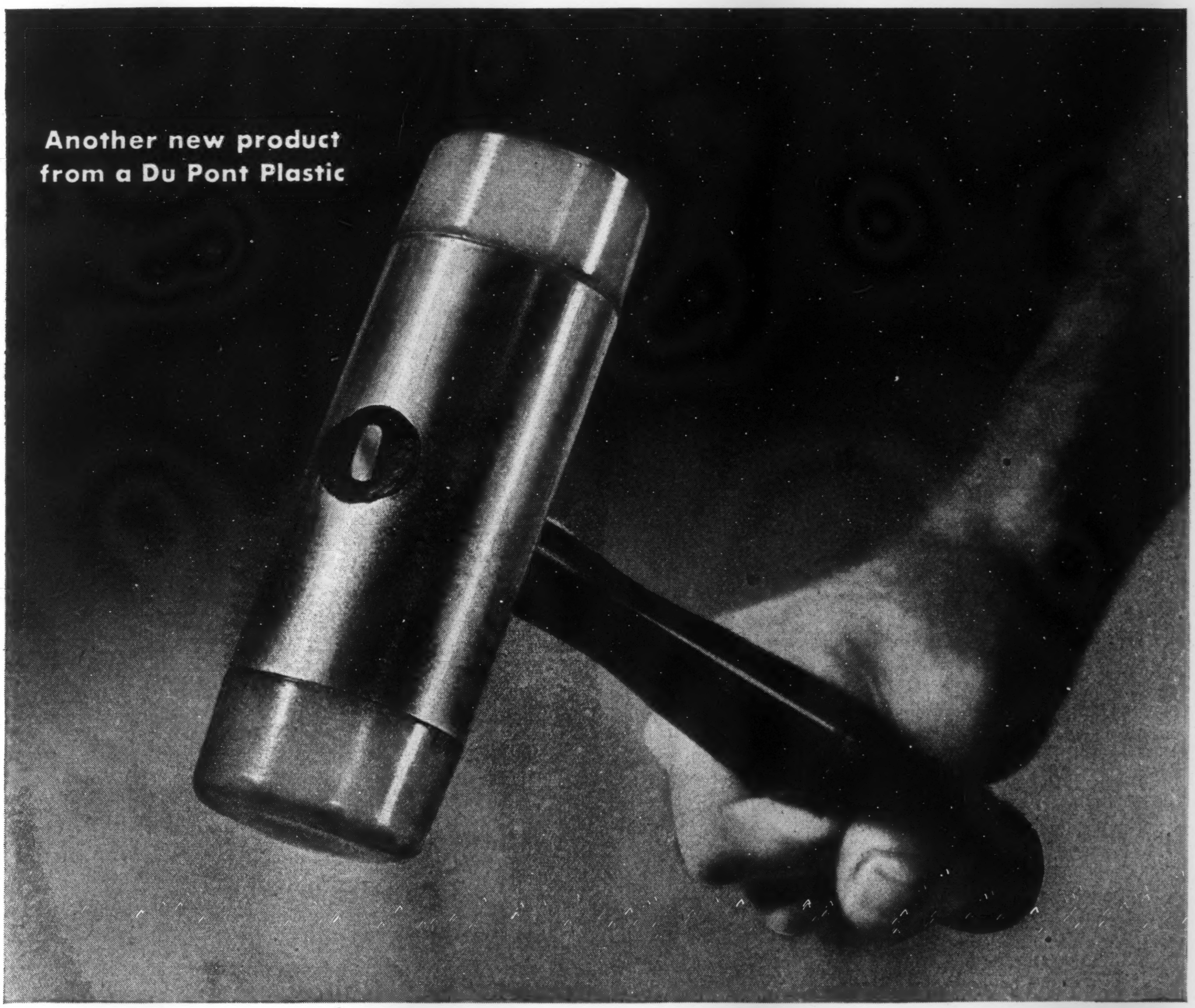

HAMMER WITH A NYLON FACE

...*saves replacement costs*

A LEADING manufacturer of loom pickers and soft impact tools set out to find a material for impact surfaces superior to all those commonly used in the manufacture of his products.

He built a machine which struck each material 140 times a minute with a sharp-pointed object giving a 50 ft.-lb. blow. Except for nylon, the best of all the materials he tested endured 60 hours. Nylon lasted over 150 hours—or for 1,260,000 of these blows—2½ times as long as the next best material.

These results, added to his knowledge of the proved qualities of nylon, so impressed this manufacturer that he chose nylon as the facing for the new and better hammer you see above.

Nylon has several important advantages over the material formerly used. It is dimensionally stable, and the face of the hammer does not work loose from the ferrule in which it is seated. Nylon does not mushroom, chip or become "doughy" from internal friction. It gives an effective blow without bouncing or marring the work. It resists industrial oils and is attractive in appearance.

Perhaps your product could be improved if you knew the facts about nylon or the entire family of Du Pont plastics. Write for literature today. E. I. du Pont de Nemours & Co. (Inc.), Plastics Department, Room 396, Arlington, N. J.

Nylon-faced hammer made by The Danielson Mfg. Co., Danielson, Conn., to be sold under the trade name "Danco-Nylon Hammer."

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Stator, cut away to show internal form, with rotor and driving connecting rod.
Here's your answer!

Perhaps you've wondered how Moyno Pumps—*without* pistons, valves, or high-speed impellers—can deliver with positive pressure; how they handle *virtually anything* that will push through a pipe; why they stand up where other pumps *fail*. It's all in the simple, patented Moyno pumping principle.

THE STATOR

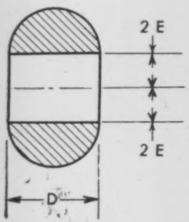

FIG. 1

A rotor-stator pumping element (above) does *all* the work; takes *all* the wear. So let us first consider the parts individually, and then put them together. For purposes of explanation, assume a forming tool made of two semi-circular discs with a rectangular section between (Fig. 1), and then assume that this forming tool (used like a hot branding iron) is *revolved uniformly* as it is pressed through a block of ice. The double-thread helical opening thus generated (Fig. 2) is our stator.

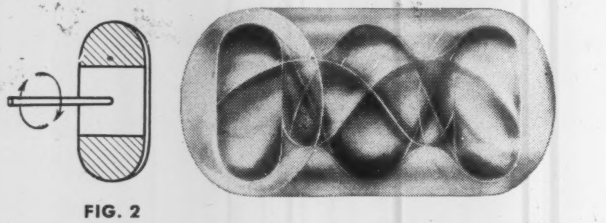

FIG. 2

Next, consider the "branding iron" as reduced to a simple disc of "D" diameter, mounted on a shaft of "E" eccentricity (Fig. 3). If this shaft were held at "E" distance *above* the axis of our stator and revolved as was the "branding iron," but with only *one-half* the lateral travel, it would feed through all of the *upper cavities* which the double-ended "branding iron" has formed.

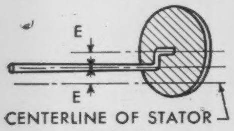

FIG. 3

THE ROTOR

Thus, if a solid rotor were made to conform with the path of this disc, it would fit into the upper portion of the stator, and leave the *lower cavities* void. Every section of such a rotor taken at right angles to its axis would be a true "D"-diameter circle, offset from the rotor axis by eccentricity "E" (Fig. 4).

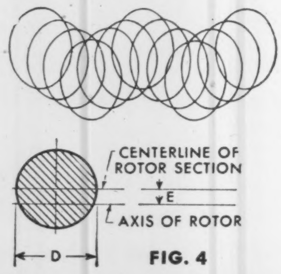

FIG. 4

In actual pump operation, the rotor executes a *compound* movement. (1) It is revolved about its axis while (2) contact between the rotor and stator causes the rotor axis to travel in a *circular path* of fixed radius "E." Total rotor "throw" thus amounts to 2E—exactly the eccentricity of our "branding iron" (Fig. 1)—so that, in each complete circuit, the rotor contacts the *entire* inner surface of the stator.

CONTINUOUS SEALING AND PRESSURE

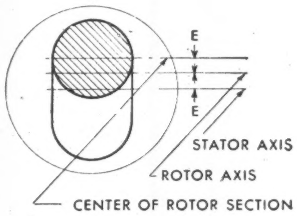

FIG. 5

A section through a stator with the rotor in place is shown by Fig. 5. Obviously, the only way the rotor-section can move is *up and down*. This is exactly what it does, and it is this reversing straight-line movement—this *continuous "wedging"*—that gives Moyno its positive pressure and uniform discharge. The rotor makes two complete revolutions while passing once around within the stator so that the hypocycloid described by the centerpoint of the rotor is a *straight line*.

Every section through the stator must contain an opening corresponding to Fig. 1—but in varying positions of rotational angularity, depending upon *where* the section is taken. Every rotor-section, therefore, travels back and forth, as just described, creating *continuous* spiraling seal lines while forcing material through the stator and automatically recreating voids at the intake end.

SWEEPING ACTION AT SEALS

The revolving rotor turns in the direction *opposite* to that of rolling rotation at the seal lines. This tends to sweep particles *away* from the seals, but should they become imbedded in the stator, the rotor will pass over them, and following pockets of fluid will flush them free.

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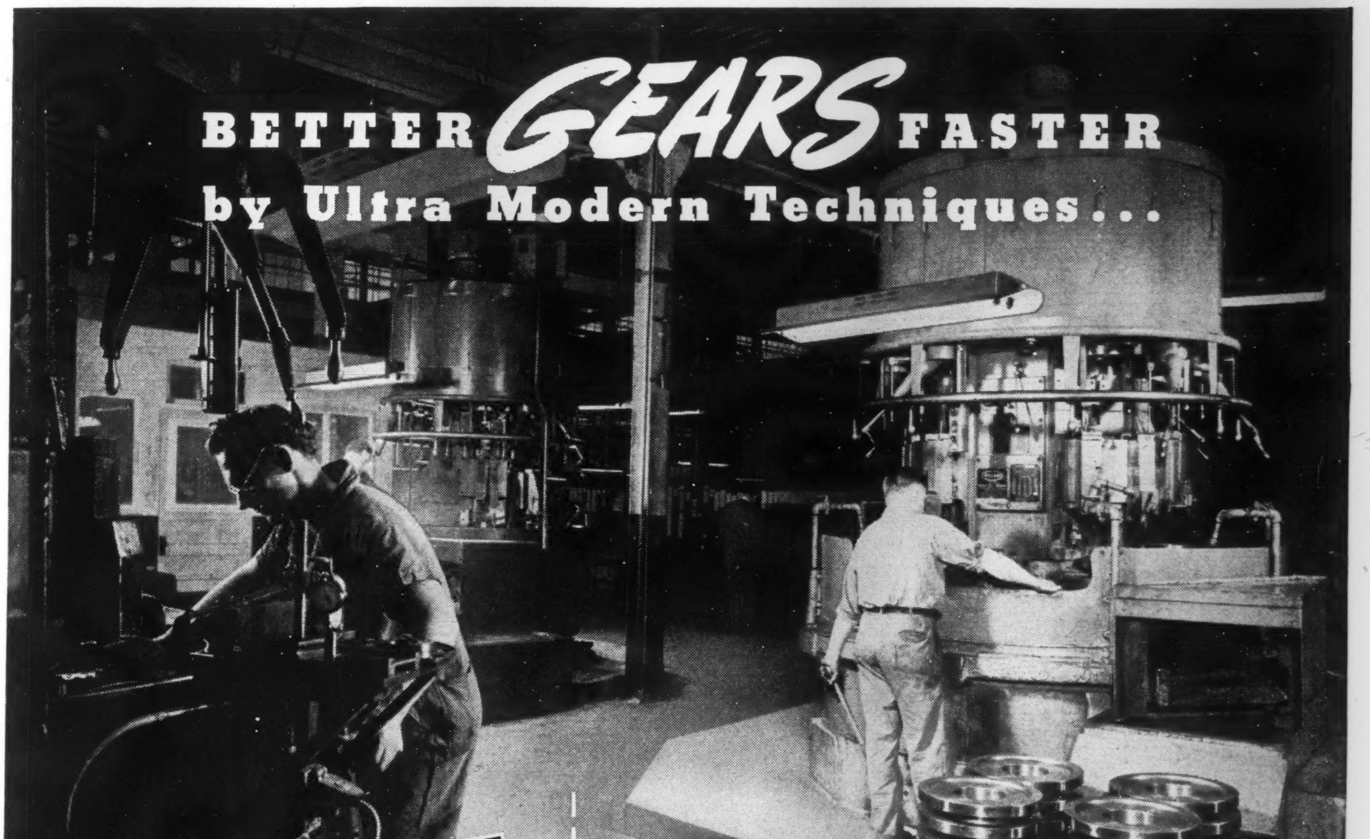
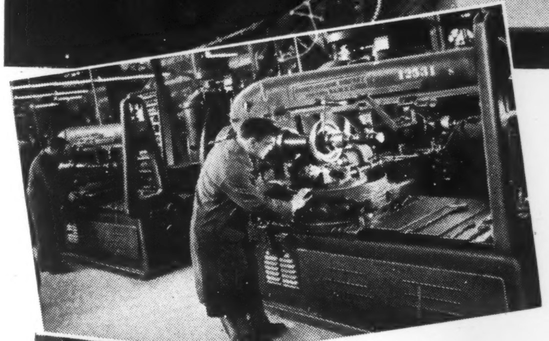
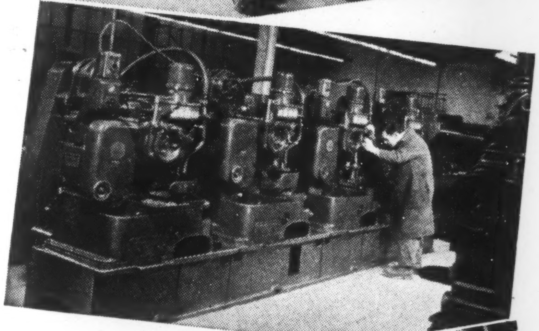
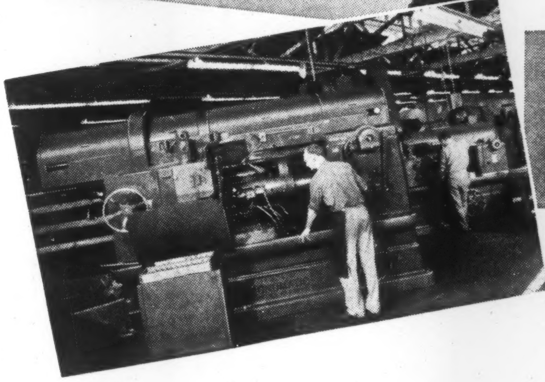


BETTER GEARS FASTER by Ultra Modern Techniques...







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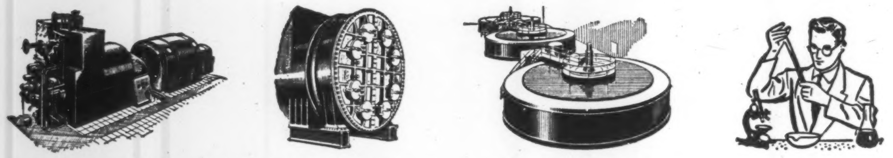

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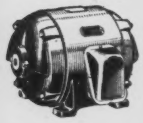
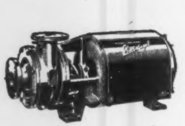
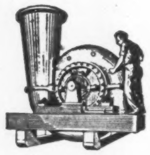


Motors — All Types

Texrope V-Belt Drives



Centrifugal Pumps



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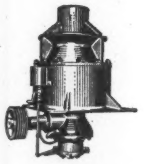

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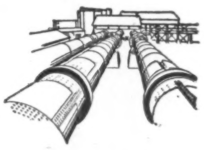
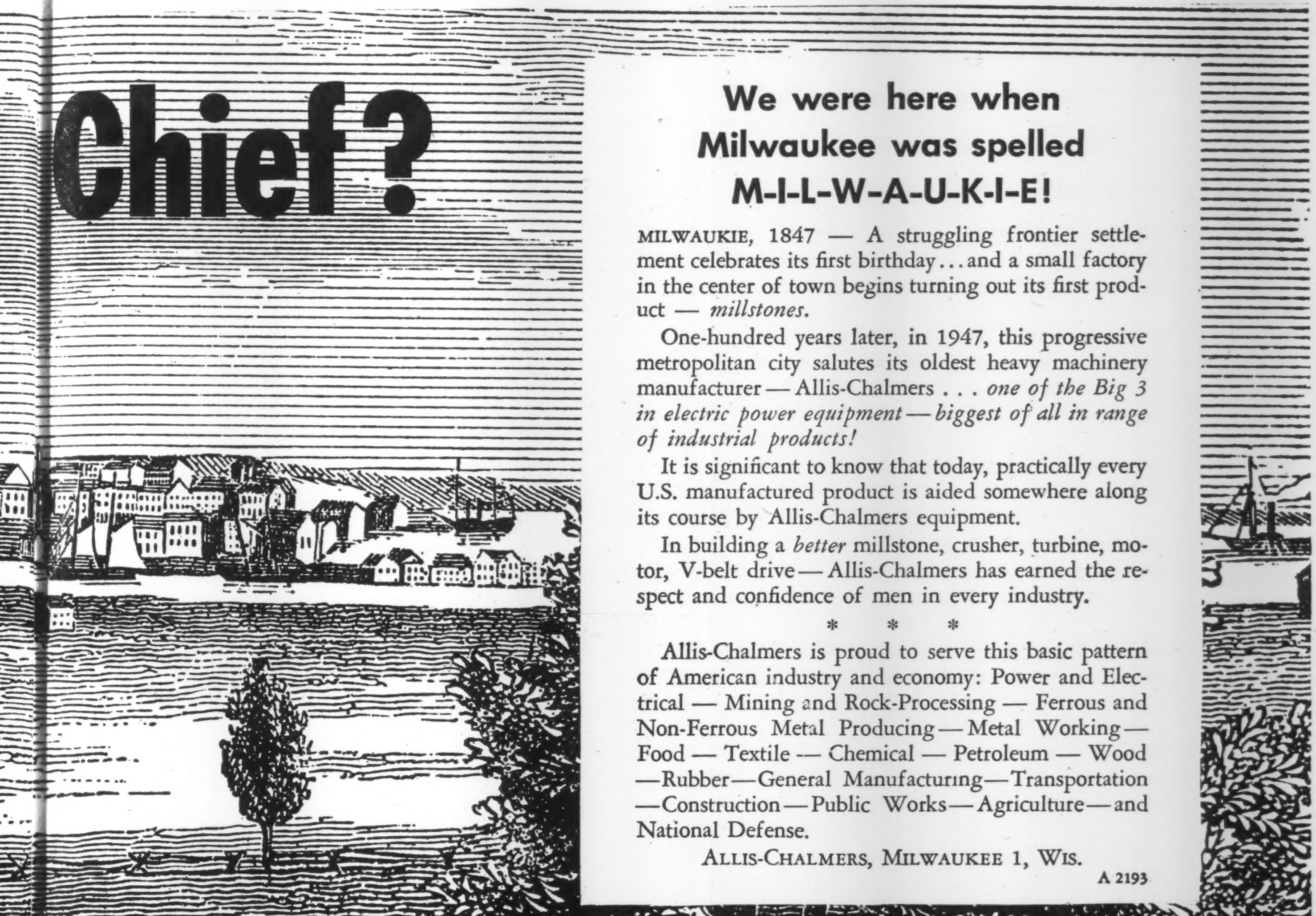


Chemical & Pyro-Process Equipment

Chief?



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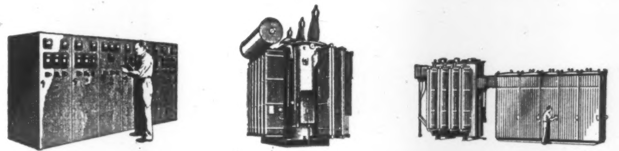

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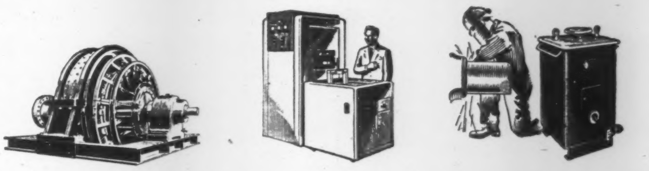

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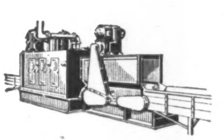

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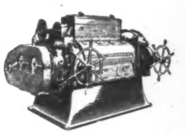

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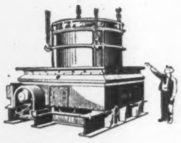

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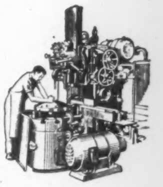
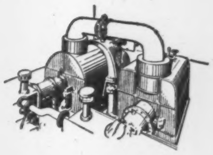


Equipment for Machine Tools



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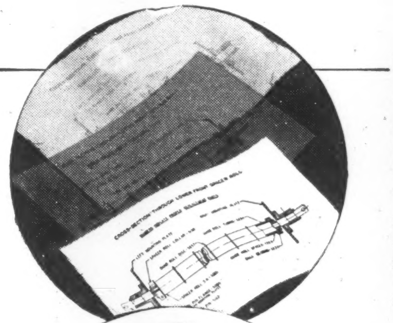

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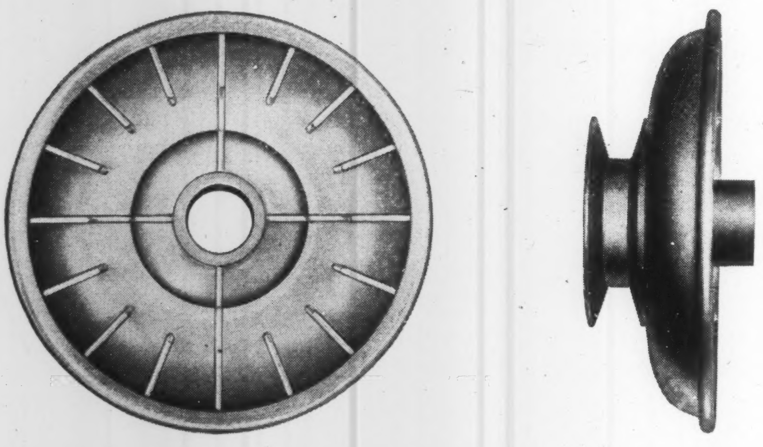

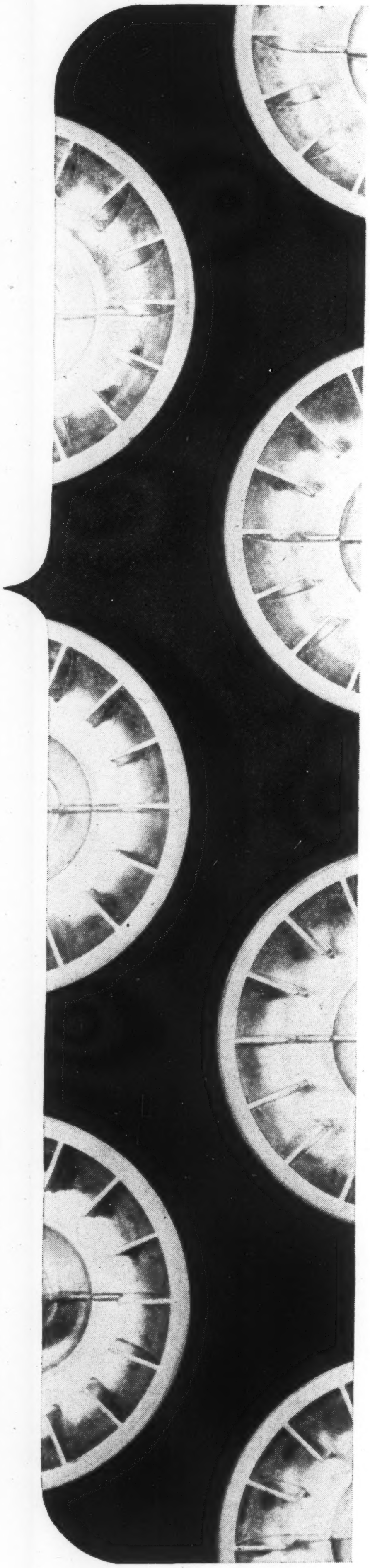

The fluid drive turbine, illustrated, is an interesting example of a one step operation from raw material to nearly finished part. The turbine blades are thin and strong. The body is both housing and pulley.

For metal parts and mechanical devices used in large quantities the die casting process often offers outstanding advantages and economies.

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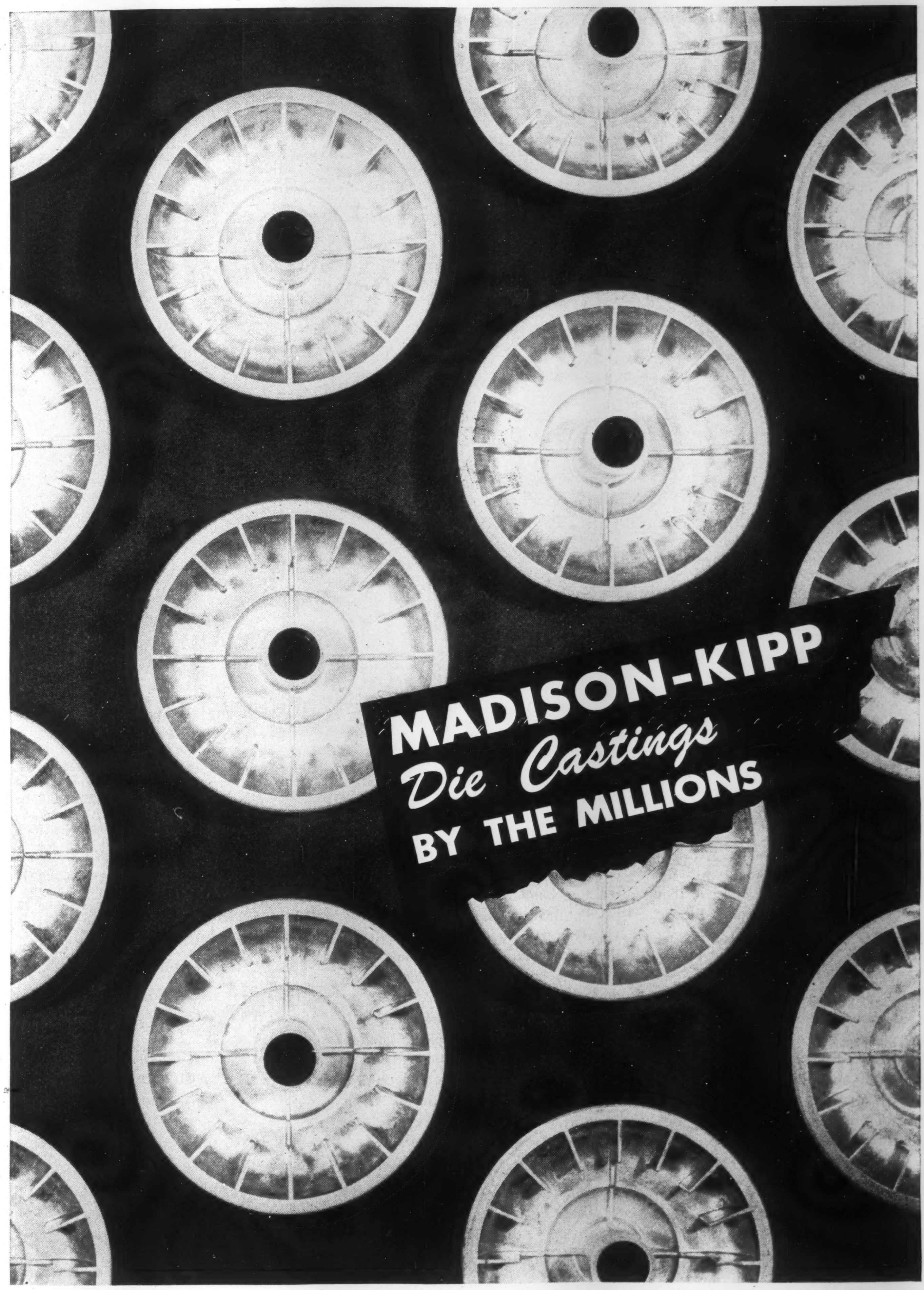
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BY THE MILLIONS

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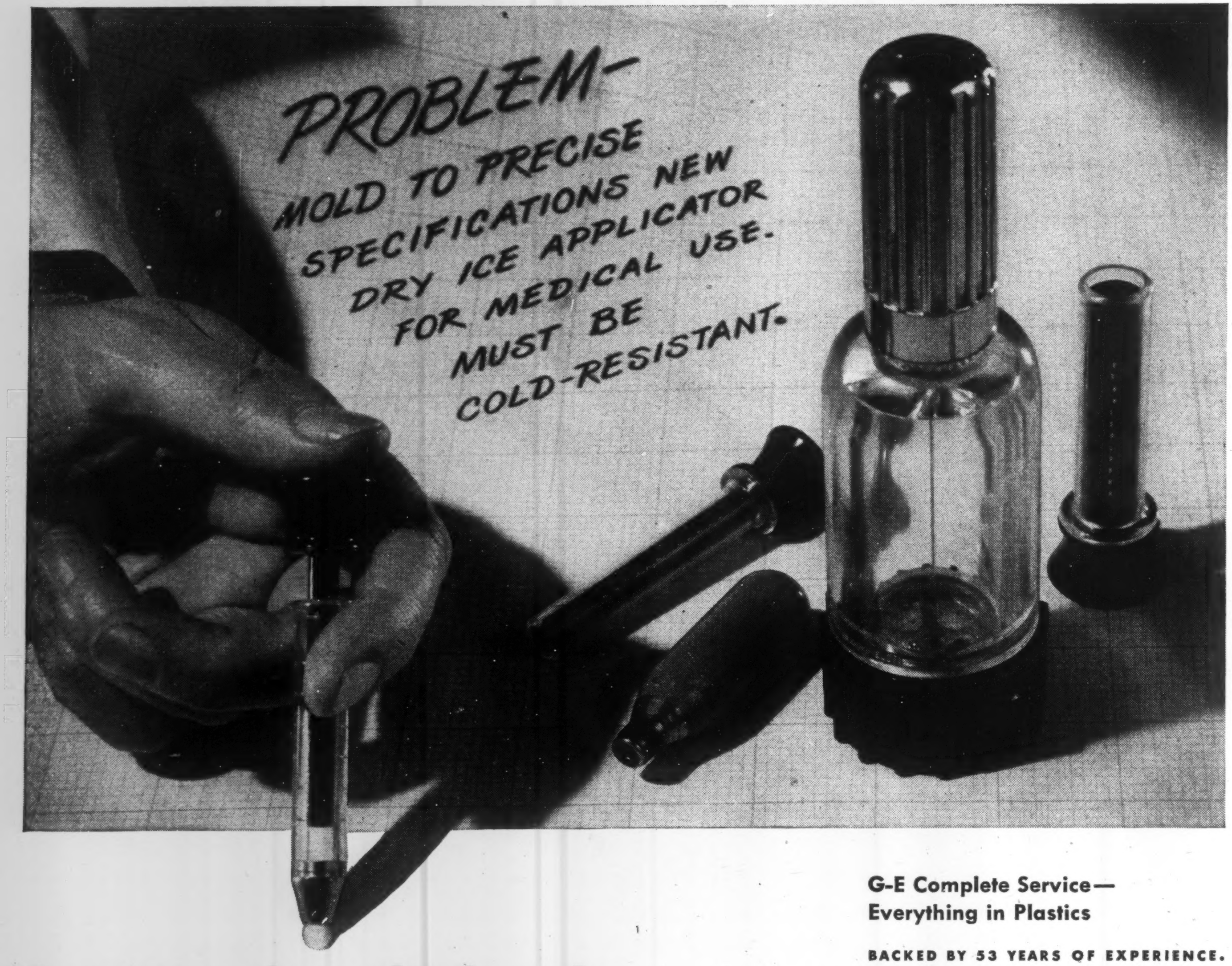

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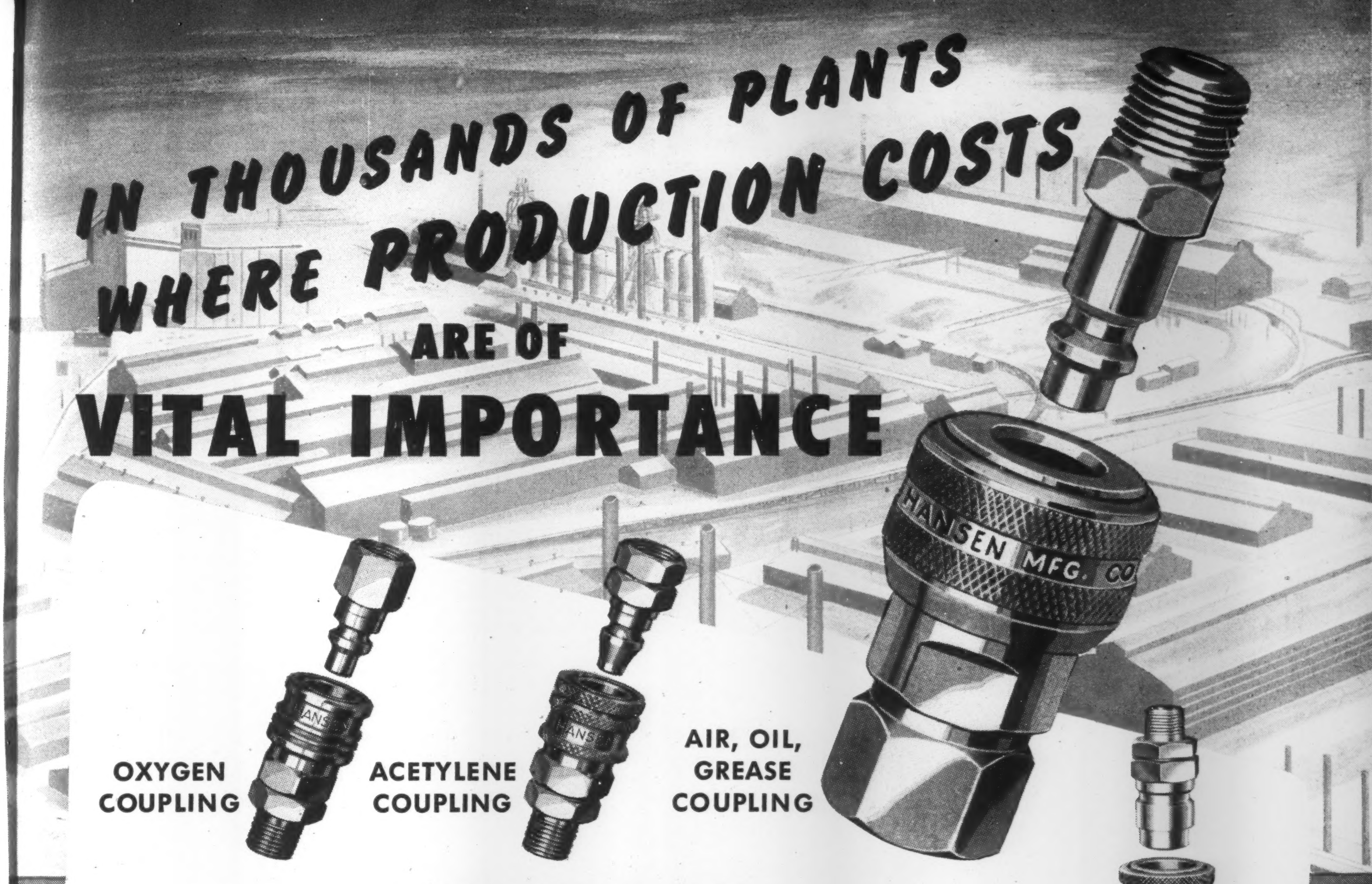


IN THOUSANDS OF PLANTS WHERE PRODUCTION COSTS ARE OF VITAL IMPORTANCE

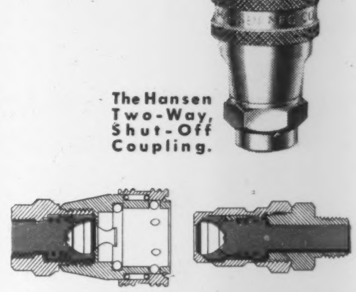
OXYGEN COUPLING

ACETYLENE COUPLING

AIR, OIL, GREASE COUPLING

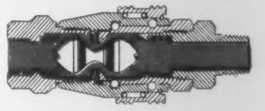
HANSEN

COUPLINGS GET RESULTS



The Hansen Two-Way, Shut-Off Coupling.

Red section shows how rubber washer in valve stem contacts valve seat in both plug and socket, sealing both plug and socket against leakage instantly.



Red section shows flow of liquid or gas around spool section of valve, permitting free flow of liquid or gas through coupling instantly upon connection.

When you use Hansen couplings, connections and change-overs become a matter of seconds — with no hold-up of costly operations. ◆ ◆ ◆ To connect a Hansen coupling on air, oil, or grease lines, you merely push plug into socket—flow is immediate and completely automatic. To disconnect, slide sleeve back with thumb, plug pops out and supply line is effectively sealed with no leaks or losses. ◆ ◆ ◆ It's the minutes saved on operations repeated over and over that add up to substantial savings. There's a Hansen coupling for every purpose or pressure requirement—for air, oil, or grease—for oxygen—for acetylene—also the new Hansen two-way shut-off coupling which completely seals both ends of line when disconnected.

Write for Industrial Catalog

THE HANSEN MANUFACTURING CO.

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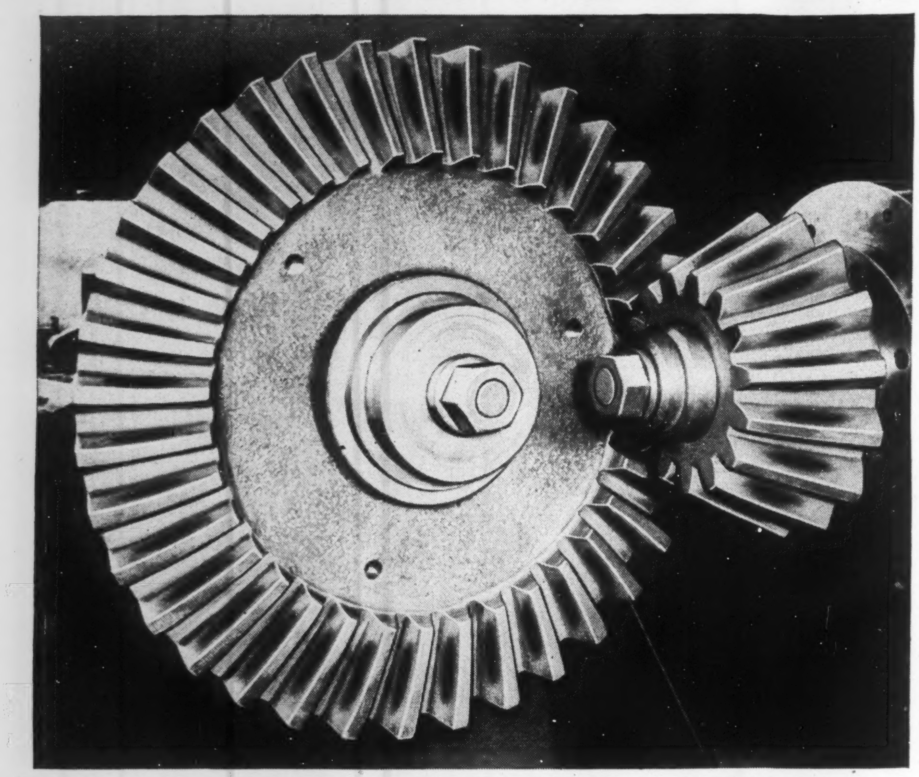
And now - "ZEROL" GEARS



Testing a large pair of Zerol gears, 15 x 36 combination, 1 D.P. These gears were cut on a Gleason Planing Generator for large spiral bevel gears. Although the teeth appear to be almost straight, they are actually slightly curved from end to end. The difference in curvature between the gear and pinion teeth controls the length of tooth contact.

. . . by PHILLIE GEAR *. . . up to 48" diameter*

Zerol gears are curved-tooth bevel gears with zero-degree spiral angle. *They combine the localized tooth contact of spiral bevel gears with the low thrust loads of straight bevel gears.*

Localized tooth contact results in smoothness, quietness and strength, even under extremely high loads. For these reasons Zerol gears are replacing straight bevel gears in many applications where thrust limitations prevent the use of spiral bevel gears.

Like straight bevel gears, Zerol gears have the advantage of no inward axial thrust under any conditions. In fact, with zero-degree spiral angle, the thrust loads are the same as for equivalent straight bevel gears, with the result that Zerol gears can be substituted for straight bevel gears, without change in thrust bearings.

Zerol gears, like other bevel gears, are designed with long and short addendum tooth proportions for smooth, quiet operation, and with large fillet radii for maximum strength.

Large Zerol bevel gears, when required, have their teeth (only) hardened on our own surface hardening machine, while smaller ones, where necessary, are hardened by the induction, straight heat treating or case hardening methods.

These gears give localized tooth bearing, which decreases stress, greatly lengthens gear life, and minimizes breakage.

We are in a position to cut gears of the Zerol bevel type up to 48″ in diameter. Write us for further information.

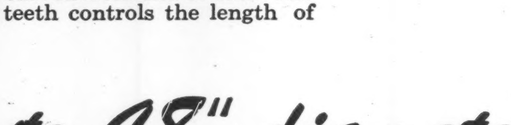
"Over 55 Years Gear Making Experience"

Philadelphia

GEAR WORKS INCORPORATED

ERIE AVE. AND G ST., PHILADELPHIA 34, PA.

NEW YORK • PITTSBURGH • CHICAGO . . .



Industrial Gears and Speed Reducers
LimiTorque Valve Controls

IN CANADA: WILLIAM AND J. G. GREEY LIMITED, TORONTO

Here's How ORCO

"SURROUNDS" PROBLEMS IN RUBBER

1. ORCO keeps abreast of constant changes in the crude rubber situation
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We invite your inquiries on specific problems

THE OHIO RUBBER COMPANY

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ELECTROL

HYDRAULIC EQUIPMENT FOR INDUSTRY

CHECK VALVES • CUT-OUT VALVES
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Distinguished by:

1. Light Weight
2. Simplified Design
3. Standardized Parts
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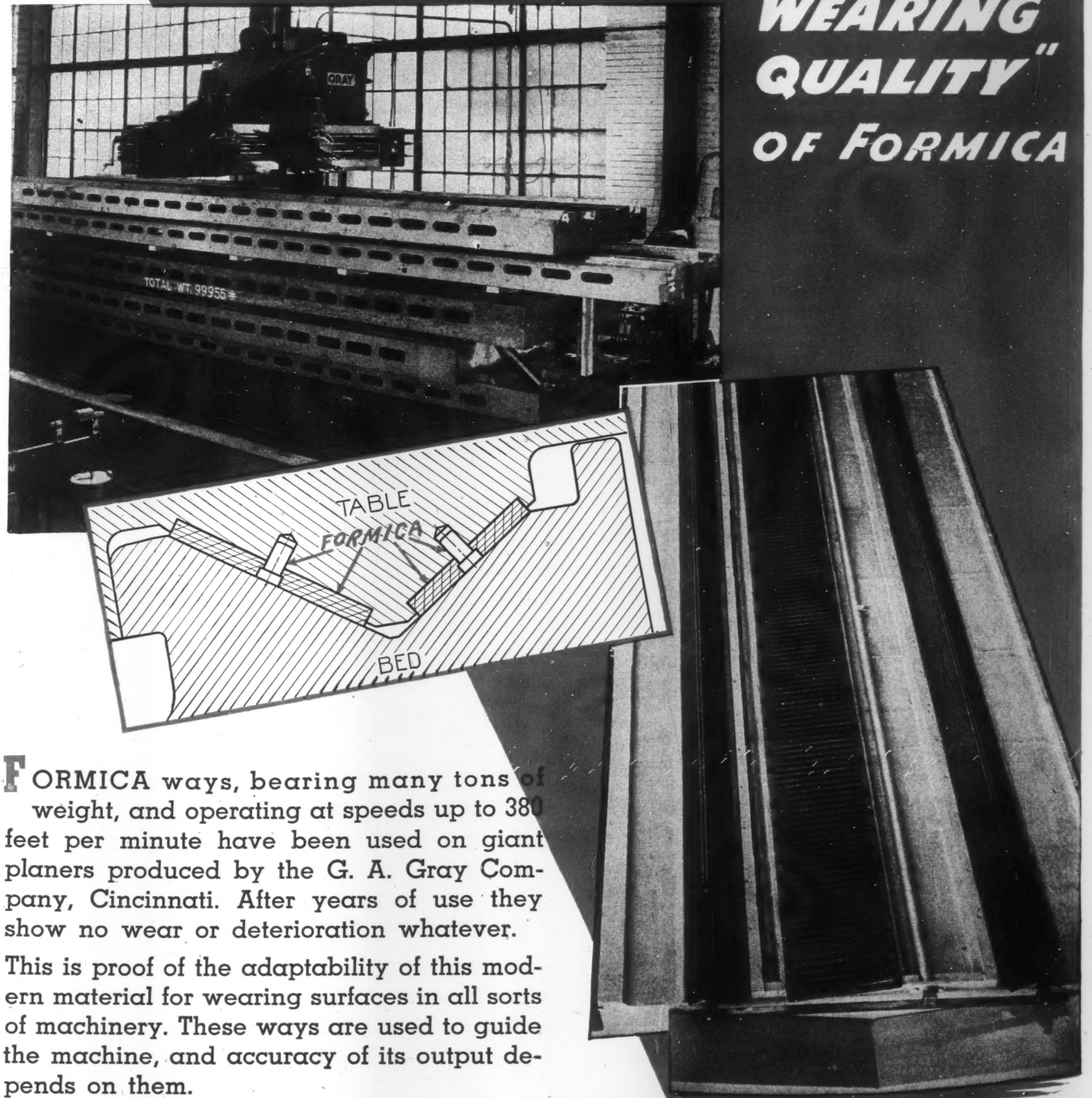
6. Long Life

There is an ELECTROL hydraulic product for every industrial use

ELECTROL INCORPORATED

FOR BETTER HYDRAULIC DEVICES
KINGSTON, NEW YORK

A JOB THAT PROVES THE "WEARING QUALITY" OF FORMICA



FORMICA ways, bearing many tons of weight, and operating at speeds up to 380 feet per minute have been used on giant planers produced by the G. A. Gray Company, Cincinnati. After years of use they show no wear or deterioration whatever.

This is proof of the adaptability of this modern material for wearing surfaces in all sorts of machinery. These ways are used to guide the machine, and accuracy of its output depends on them.

They have a non-scoring and wear-resisting quality that makes them the best of possible materials for the purpose. Another important quality for high speed operation under heavy weight is their heat-insulating quality. This prevents heat penetrating to the metal table support, changing its dimensions and causing it to curl.

Formica engineers will be glad to discuss similar applications and recommend the most desirable grades.

FORMICA

TRADE MARK REG. U.S. PAT. OFF.

THE FORMICA INSULATION CO., 4648 SPRING GROVE AVENUE, CINCINNATI 32, OHIO

Greater Load Capacity with McGILL

SOLIDEND MULTIROL Bearings

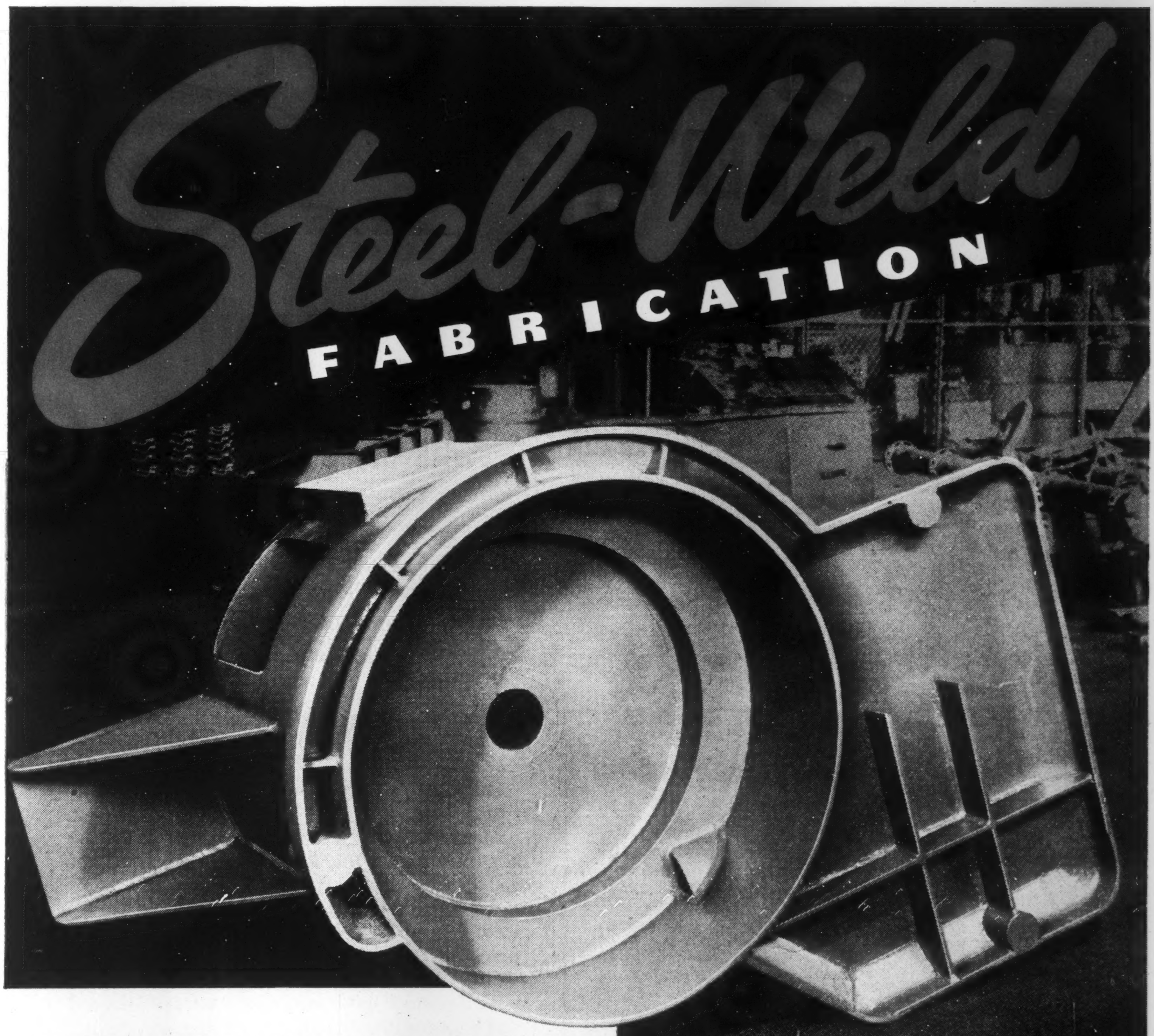
The full length, rounded end rollers, used in the "Solidend" Multirol Bearing, increase the contact surface between race and rollers. This gives the McGill Bearing a greater load capacity and a longer, trouble-free life. The solid retaining end shoulders built integral with the outer race eliminate flimsy end washers and loose retaining rings. As a result "Solidend" Multirol Bearings can be used with or without the inner raceway.

An application of these bearings is in the Boom Hoist mechanism of Thew-Lorain Moto-Cranes and Crawler Mounted Machines.

For further information write for catalog SM-42.

McGILL MANUFACTURING CO., INC.
Manufacturers of Ball and Roller Bearings
VALPARAISO - INDIANA

Steel-Weld
FABRICATION



Steel-Weld Fabrication brings out the pride of accomplishment in both designers and craftsmen . . . it challenges the ingenuity of designers as well as the skill of workmen who cut, bend, shape, and do the actual welding. In the Mahon organization, where every modern facility is available to encourage superior workmanship, this pride of accomplishment is responsible for the finer finished appearance of work leaving the Mahon plant. Regardless of what your requirements may be, Mahon design engineers stand ready to assure you every advantage of Steel-Weld Fabrication.

Address STEEL-WELD DIVISION
THE R. C. MAHON COMPANY
Detroit 11, Michigan

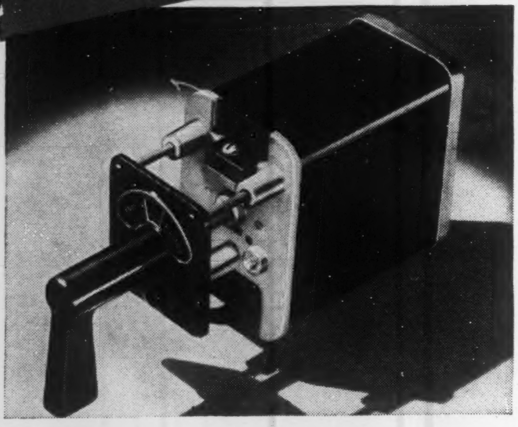
Engineers and Fabricators of Welded Steel Machine Bases and Frames, and Many Other Welded Steel Products

MAHON

DESIGNER'S *Digest*

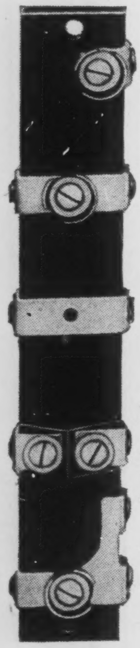
ONE SWITCH

...with more than 7000 uses



For applications up to 600 volts, 20 amperes — from ON-OFF to complicated-sequence switching — you can get an "exactly right" switch for any application, easily, quickly and economically.

Pick the contact type you need



Single-break contact	*for*	simple control arrangements, also staggered contact arrangements.
Two single-break contacts, center connection	*for*	single-pole, double-throw arrangements.
Two single-break contacts, in series	*for*	single-pole, single-throw with double-break interrupting capacity.
Two single-break contacts, separate connections	*for*	two-pole, single-throw arrangements.
Three single-break contacts, common connection	*for*	opening and closing a device with one circuit.

Imagine a control and transfer switch made up of standard parts, yet so flexible in its application that designers have used it in more than 7000 different arrangements! That's the G-E Type SB-1 switch.

For ordinary control jobs, you specify the ordinary type. On highly specialized applications, you still benefit from standardization. By using *standard* cams, contacts, fingers and other parts, we build you a "custom-made" switch to control practically any sequence of operations *and* at the price of a standard unit.

G-E control and transfer switches are designed and built for extra reliability and long service life. Important construction features are silver-to-silver contacts, anti-arcing barriers between adjacent circuits, sturdy Textolite face plates, and attractive switch handles. For complete details and contact possibilities, check Bulletin GEA-1631E.

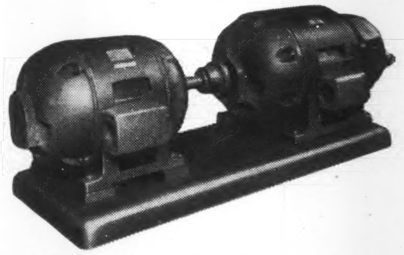
For Extra Heavy Duty Service!

When you need a control switch to perform many thousands of repetitive operations per week, use a unit that has extra strength "built in" — G. E.'s master control switch, Type SB-9. Steel mills like the way it stands up to heavy circuit control jobs. Every part — contacts, gears, shunt connections, even handles are made extra strong to resist wear. Ask for Bulletin GEA-4114.

GENERAL ELECTRIC

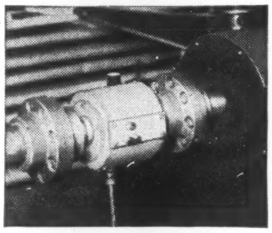
TIMELY HIGHLIGHTS ON G-E PRODUCTS

High Speeds... MADE EASY!



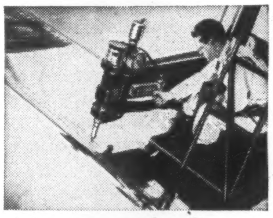
Many grinding and woodworking machines, as well as portable hand tools, have high-speed motors which require frequencies above the regular power supply. G-E induction frequency converters will supply 120, 180, 240, 360 and 420 cycles for these jobs. The converter is designed for constant excitation from a polyphase a-c supply and may be furnished alone or in combination with a driving motor. Ask your nearest G-E office for further information on induction frequency converters or frequency converter sets.

Tells pound-feet... WITHOUT CRADLING!



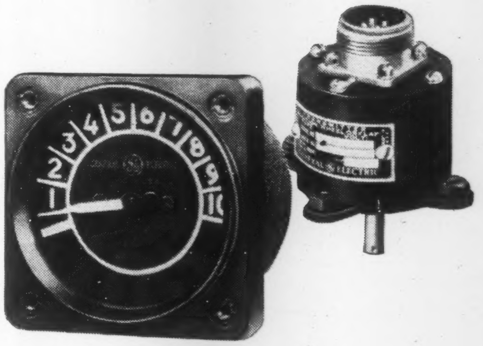
This G-E electromagnetic torque meter is surprisingly easy to use. You simply couple the shaft unit between the load and the driving unit, start the machine, and take your readings. Cradling the load or fussing with scales is unnecessary. The meter measures torque directly without absorbing power from the load. This instrument consists of a shaft unit, oscillator, power unit, and indicating devices. Absolute accuracy within plus or minus 1 per cent of full-scale reading is provided. Check Bulletin GEA-4441A on coupon.

Better Welders... TRAINED FASTER!



The war years proved the value of visual employee training methods. Output climbed, rejects dropped. Now G. E. has produced a new full-color sound movie that illustrates by animated sketches the principles and uses of three types of resistance welding — spot, projection, and seam. More than 100 applications are shown in fifteen different industrial plants. Accompanying the film is an interesting bulletin which reiterates the key points made in the film. The film, part of G.E.'s MORE POWER TO AMERICA program, is available for loan without charge from your local G-E office.

POSITIONS MADE CLEAR ...from remote stations!



Thousands of military aircraft found one or more uses for G-E position-indicating equipment. Many of the jobs called for high accuracy and complete reliability in remote transmission of position signals. Now G. E. believes that industrial designers can take advantage of this wartime development. To that end, our engineers are ready to help you investigate application possibilities on your machines, large or small.

One of the new position-indicating arrangements perfected by G. E. is a d-c selsyn three-wire system. Transmitters will operate in an ambient temperature range from —85 F to 158 F and are weather resistant. Indicating instruments are available in two standard sizes — 1⅞-inch dial with 1 or 2 pointers and 2¾-inch dial with 1, 2, 3, or 4 pointers. Dial markings are made to meet your requirements.

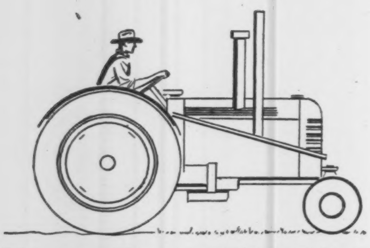
A single d-c selsyn indicating system consumes about 2 watts at either 12 or 24 volts. Any reasonable lead length may be used. Two indicating instruments can be operated from the same transmitter. Bulletin GET-1304 is a comprehensive application manual you'll find extremely helpful. Check it on the coupon.

TO GENERAL ELECTRIC COMPANY
Section F668-54, **Schenectady 5, N. Y.**
Please send me the following information:

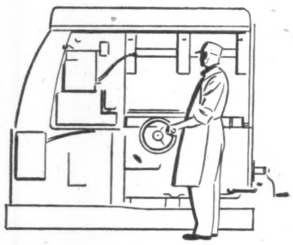
_____GEA-1631E (Control and transfer switches)	_____GEA-4441A (Torque meter)
_____GEA-4114 (Master control switches)	_____GET-1304 (Position-indicating system manual)

Name____________________
Company____________________
Street____________________
City____________________State__________

CONSULT YOUR SWEET'S! You'll find "everything electric" for machinery manufacturers in the General Electric section. 8579



From Farm Machinery



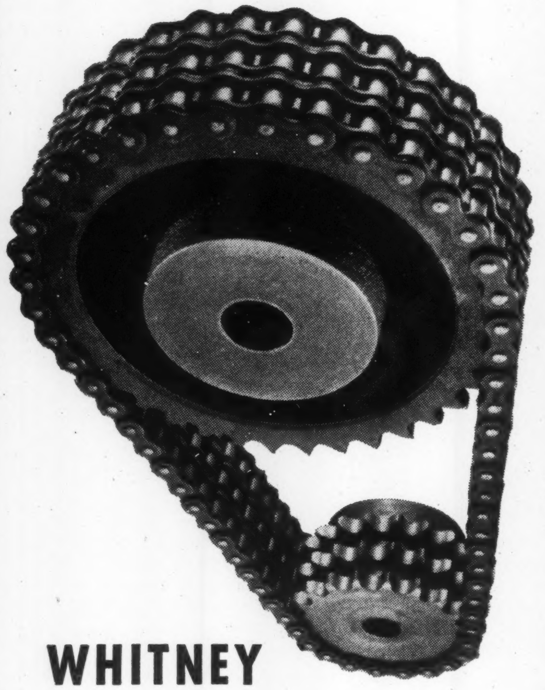
To Machine Tools...

Chain Drive IS BETTER

- *ADAPTABLE TO ALL DESIGN PROBLEMS*
- *POSITIVE GRIP ASSURES EFFICIENT POWER TRANSMISSION*
- *LONG OPERATING LIFE WITH MINIMUM MAINTENANCE*

Whether it's stationary or portable equipment . . . textile or agricultural machinery . . . chain power drive gives highest transmission efficiency. The positive grip eliminates power loss due to slippage and frictional contacts. Because chain drive transmits constant motor speed, it helps maintain product uniformity, cuts down rejections. Its flexibility and adaptability simplify design problems . . . provide a wide range of selection to every application. Chain drive is easy to install, easy to remove without disconnecting shafts . . . has high shock load capacity . . . does not require frequent adjustments to maintain tension . . . gives long-lived performance with little maintenance.

Investigate chain drive for your designs. Whitney Engineers will gladly help you with your problems. Write:



WHITNEY ROLLER CHAINS

These chains deliver constant, full power smoothly and efficiently. They stand up under the severest operating conditions. All parts are made of alloy steel, hardened to give maximum service with minimum wear. Whitney Roller Chains are available in many types in pitches from ⅜″ to 2½″. Write for complete specifications.

The Whitney Chain & Mfg. Company, Hartford 2, Connecticut

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Plastics where plastics belong

A rare combination of mechanical, electrical, and chemical properties fit Synthane (our type of plastic) for a countless number of useful applications. Aside from its moisture and wear resistant qualities, Synthane is also light, dense, strong, easily and quickly machined, an excellent insulator, and a material for fighting corrosion.

Here is a unique and dramatic example of the use of plastics where plastics belong and Synthane where Synthane belongs.

EVINRUDE
for resistance to moisture and wear

This outboard motor pivot bearing (above) requires no lubrication . . . resists both salt and fresh water, wears long and well . . . it's Synthane.

If these few of Synthane's many properties suggest a possible use of Synthane in your product, let us help you—in the design stage. Perhaps we can save you time and money. Meanwhile, get further information. Send today for the complete catalog of Synthane technical plastics. Synthane Corporation, 5 River Road, Oaks, Pennsylvania.

SYNTHANE S **where Synthane belongs**

DESIGN · MATERIALS · FABRICATION · SHEETS · RODS · TUBES
FABRICATED PARTS · MOLDED · MACERATED · MOLDED-LAMINATED

(over)

COMPETITION TO REACH PREWAR PITCH IN '47

Speaker Warns Race Has Started

Last night a group of local manufacturers heard John R. Brown, prominent market analyst, tell them "the honeymoon in business is over." The speaker, addressing an industrial association banquet, said 1947 would see a return to the era of "best product, best sales." Warning small and large businesses alike he reported . . .

READY FOR THE "PROFIT HANDICAP"?

Cost-plus thinking and easy profits have reached the end of their rope according to all business barometers. Business is once again off to a free enterprise race.

Better products for less manhours and lower costs are now interesting production managers, product engineers and purchasing agents and they are showing intense interest in methods and materials that promise these improvements.

Synthane (our type of laminated plastics) is made to order for current designing. Its combination of properties, makes it applicable to literally thousands of uses. It is, for example, one of the best of electrical insulators. It is also moisture, corrosion and wear resistant, possesses high mechanical strength and can be quickly and easily machined.

Synthane may help solve one of your product problems. If you feel you have a use for Synthane, let us help you before you design. We may be able to save you time, effort and money and help put you "out in front" of competition. Send the coupon below for your copy of the Synthane Plastics Catalog.

Here's how to get a "Head-Start" on Competition

SYNTHANE CORPORATION, 5 RIVER ROAD, OAKS, PA.

Gentlemen:

Please send me without obligation the complete catalog of Synthane technical plastics.

Name________________________

Company________________________

Address________________________

City____________ Zone______ State______

SYNTHANE

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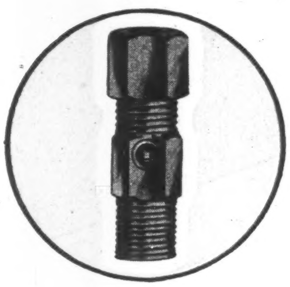
PLAN YOUR PRESENT AND FUTURE WITH SYNTHANE TECHNICAL PLASTICS • SHEETS • RODS • TUBES • FABRICATED PARTS • MOLDED-LAMINATED • MOLDED-MACERATED



PULSOLATOR

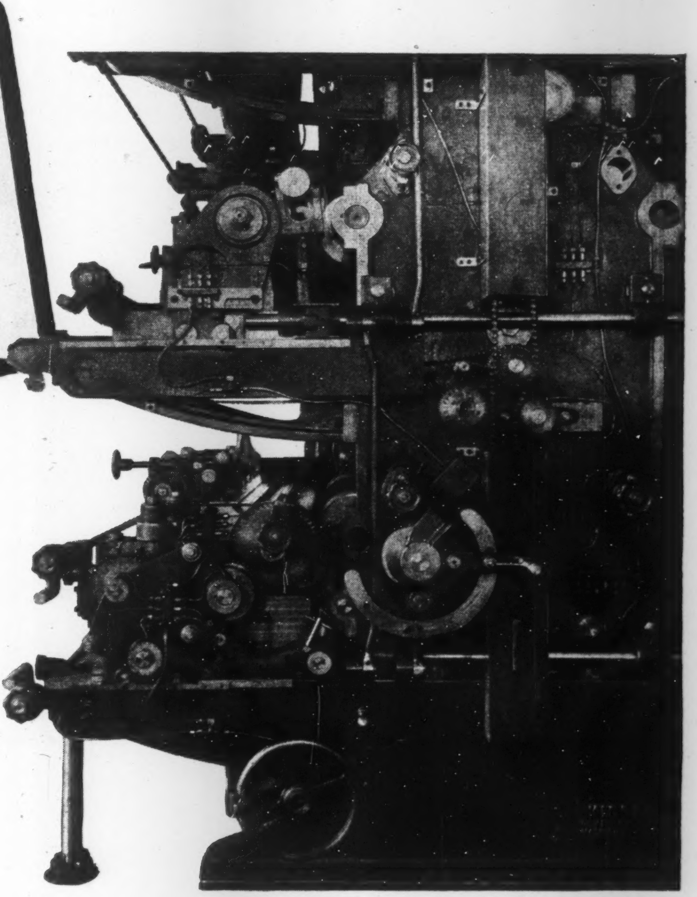
Lubricating Lifelines

For more than twelve years, 6,660 bearings on Kidder Printing Presses have depended upon this control feed lubrication system to maintain automatically their required oil film.

Write today for Pulsolator's proven performance record on printing presses like Kidder. See how it does a big job with little effort, reduces operating and maintenance costs, and adds greatly to the earning power of machines by providing automatic lubrication.

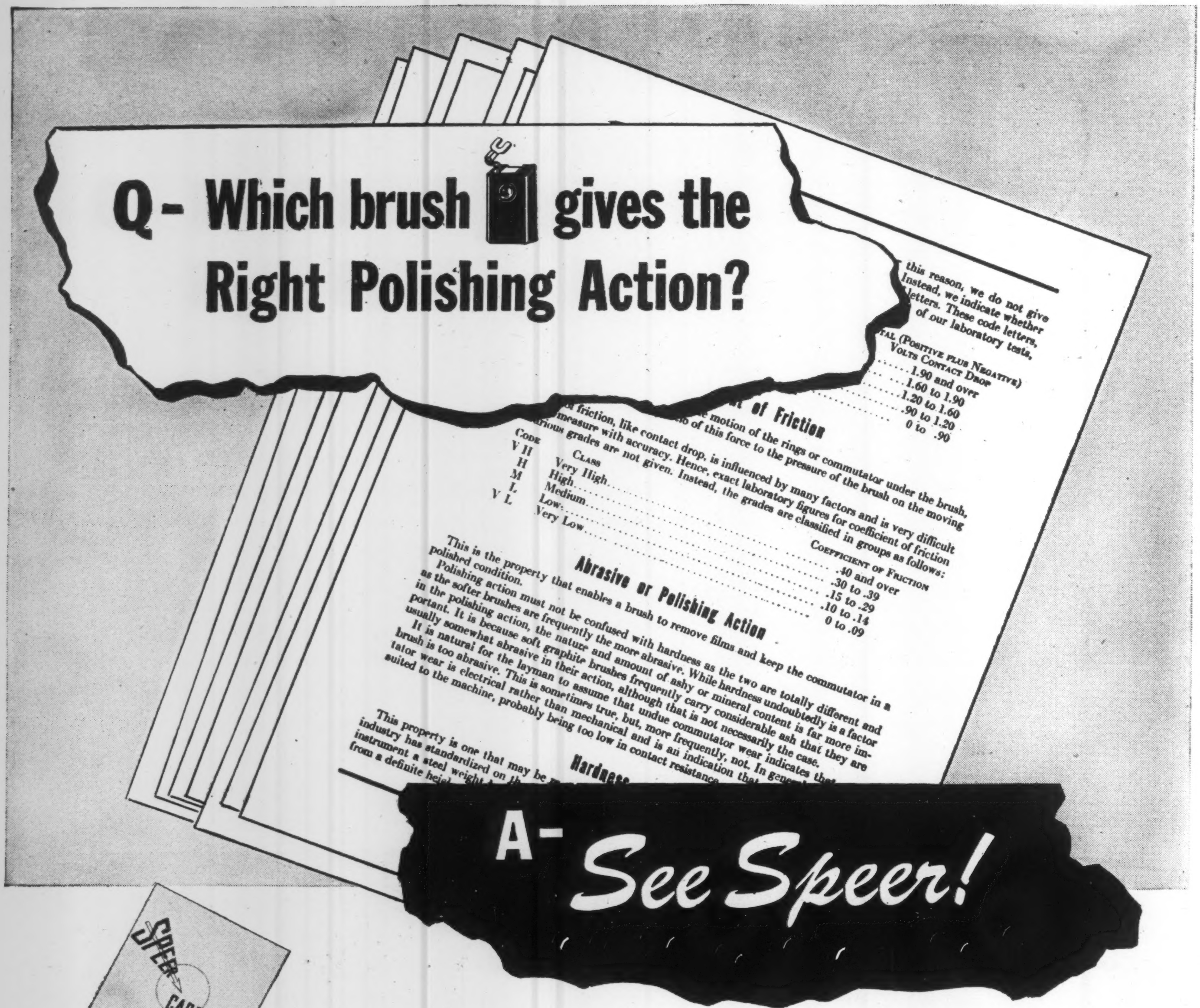
Let a Rivett engineer plan the exact system to be built into your new machines or applied to existing ones. Engineers and machine designers should have up-to-date and complete information on such systems. Send for your copy of Pulsolator's Engineering Manual.

to 6,660 BEARINGS
on KIDDER
Printing Presses



LUBRICATION DIVISION
RIVETT LATHE & GRINDER INC.
BRIGHTON • BOSTON • MASS.

Q- Which brush gives the Right Polishing Action?



this reason, we do not give
Instead, we indicate whether
letters. These code letters,
of our laboratory tests,

	TAL (POSITIVE PLUS NEGATIVE) VOLTS CONTACT DROP
	1.90 and over
	1.60 to 1.90
	1.20 to 1.60
	.90 to 1.20
	0 to .90

of Friction

e motion of the rings or commutator under the brush, o of this force to the pressure of the brush on the moving friction, like contact drop, is influenced by many factors and is very difficult measure with accuracy. Hence, exact laboratory figures for coefficient of friction rious grades are not given. Instead, the grades are classified in groups as follows:

CODE	CLASS	COEFFICIENT OF FRICTION
V H	Very High	.40 and over
H	High	.30 to .39
M	Medium	.15 to .29
L	Low	.10 to .14
V L	Very Low	0 to .09

Abrasive or Polishing Action

This is the property that enables a brush to remove films and keep the commutator in a polished condition.

Polishing action must not be confused with hardness as the two are totally different and as the softer brushes are frequently the more abrasive. While hardness undoubtedly is a factor in the polishing action, the nature and amount of ashy or mineral content is far more important. It is because soft graphite brushes frequently carry considerable ash that they are usually somewhat abrasive in their action, although that is not necessarily the case.

It is natural for the layman to assume that undue commutator wear indicates that brush is too abrasive. This is sometimes true, but, more frequently, not. In gener tator wear is electrical rather than mechanical and is an indication that suited to the machine, probably being too low in contact resistance

Hardness

This property is one that may be industry has standardized on th instrument a steel weight from a definite hei

A- See Speer!

SPEER
CARBON PRODUCTS

MORE ANSWERS in this book. Get it!

This catalog, *SPEER CARBON PRODUCTS*, gives detailed information on brush characteristics, includes Speer Brush Data Sheets. It answers your questions on brush selection, helps you find the right brush for your motors or generators!

A brush with the *right polishing action* keeps the commutator clean and without undue commutator wear. A brush with the *right polishing action* means top efficiency and long life for your commutating machines!

Selecting the brush with the right degree of polishing action for your particular requirements—selecting the *one* brush with the right combination of *all* the vital characteristics for your specific operating conditions is a specialty at SPEER! That's why Speer Brushes bring increased efficiency wherever they are installed!

SPEER
Speer
CARBON COMPANY
ST. MARYS, PENNA.

2528

brushes • contacts • welding electrodes • graphite anodes • rheostat discs • packing rings • carbon parts

CHICAGO • CLEVELAND • DETROIT • MILWAUKEE • NEW YORK • PITTSBURGH

Now, For The First Time....

The Measured Quality of Each Lot of Springs Can Be Seen at a Glance

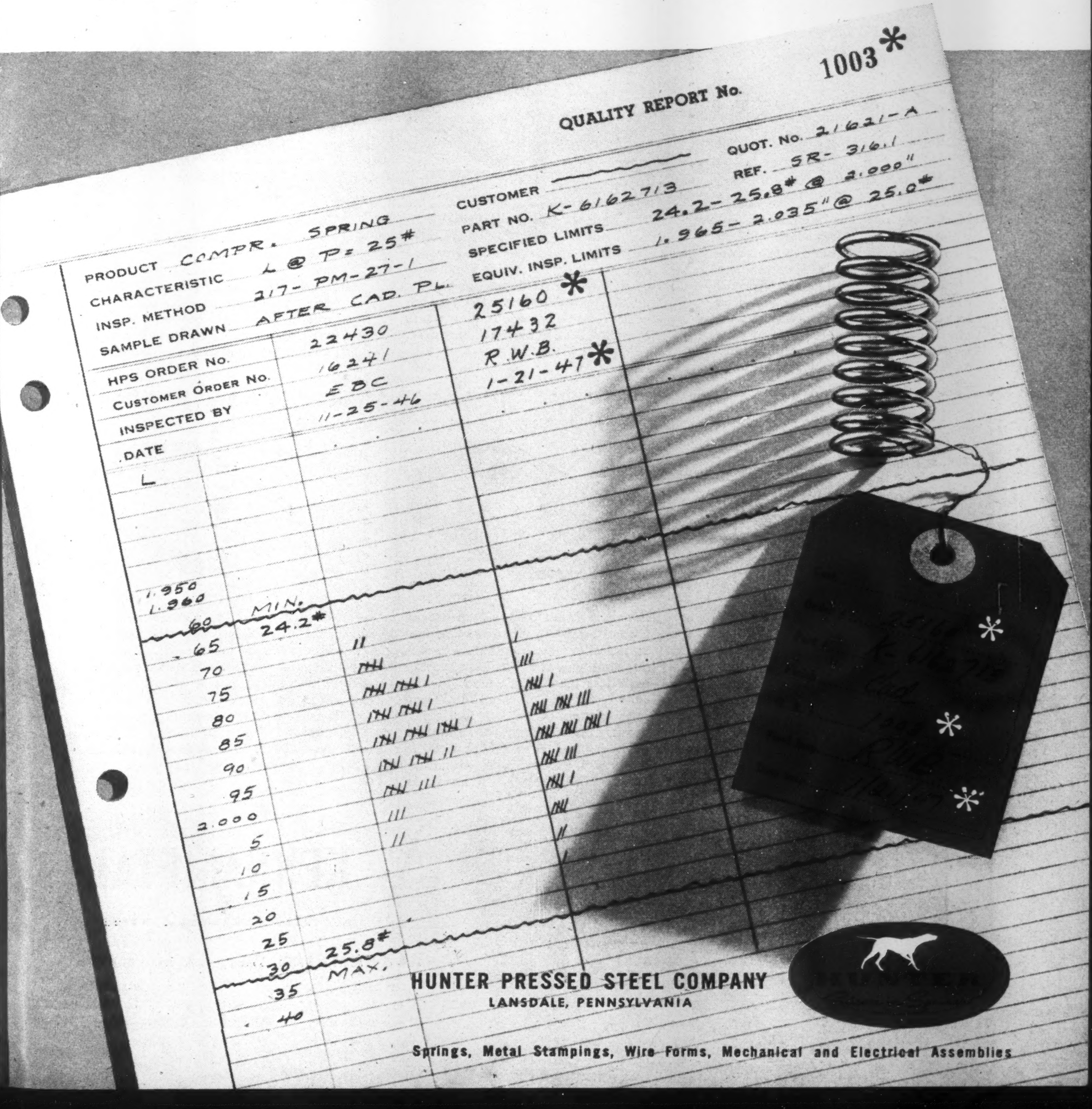
Quality Engineers have long predicted that some day suppliers would submit a record of quality to their customers and that this record would become part of a new era in vendor-customer relationships.

That day is here for Hunter customers.

Hunter now makes available to customers a report of the measured test loads for *every* lot of springs in the form of a frequency distribution. These Q.R.'s (Quality Reports) will be mailed to chief engineer, inspector or other person designated. The Q.R. of the sample drawn from *each* lot of *every* item will be sent as the lot clears Hunter's final inspection.

These reports enable one to compare quality lot-for-lot, consider tolerance revisions, reduce customers' sampling without sacrificing quality insurance . . . will lead eventually to a comparison of quality vendor-for-vendor.

Hunter believes it is the first in industry to make this valuable service available to all customers.



QUALITY REPORT No. 1003*

PRODUCT COMPR. SPRING
CHARACTERISTIC L @ P = 25#
INSP. METHOD 217-PM-27-1
SAMPLE DRAWN AFTER CAD. PL.

CUSTOMER
PART NO. K-6162713
SPECIFIED LIMITS 24.2-25.8# @ 2.000"
EQUIV. INSP. LIMITS 1.965-2.035" @ 25.0#

QUOT. No. 21621-A
REF. SR-316.1

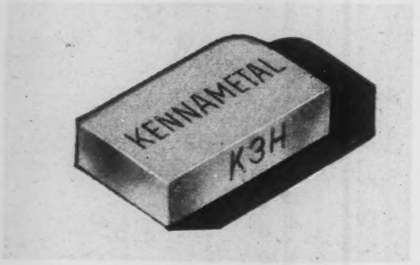
HPS ORDER No.	22430	25160 *
CUSTOMER ORDER No.	16241	17432
INSPECTED BY	EBC	R.W.B.
DATE	11-25-46	1-21-47 *

L			
1.950 1.960			
60	MIN. 24.2#		
65		II	I
70		𝍸	III
75		𝍸 𝍸 I	𝍸 I
80		𝍸 𝍸 I	𝍸 𝍸 III
85		𝍸 𝍸 𝍸 I	𝍸 𝍸 𝍸 I
90		𝍸 𝍸 II	𝍸 III
95		𝍸 III	𝍸 I
2.000		III	𝍸
5		II	II
10			I
15			
20			
25			
30	25.8# MAX.		
35			
40			

HUNTER PRESSED STEEL COMPANY
LANSDALE, PENNSYLVANIA

Springs, Metal Stampings, Wire Forms, Mechanical and Electrical Assemblies

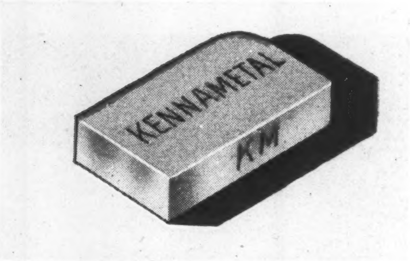
IT PAYS TO KNOW *Your* KENNAMETAL *GRADES!*



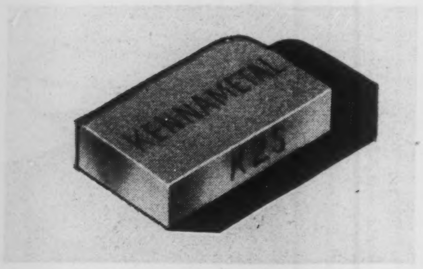
Most crater-resistant Kennametal tool material—gives outstanding service for finishing or moderate cuts on carbon and alloy steels .30% carbon and higher. Also time-and money-saver for general use on soft steels containing less than .30% carbon, precision boring of steel where .004" feed or over is used, and for many milling jobs on steel. 92 Rockwell A hardness.

KENNAMETAL
K5H

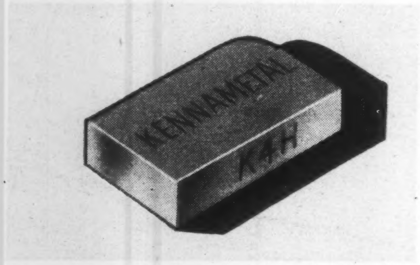
The hardest Kennametal tool material grade — specifically for solid tools used on precision boring of steel parts. Its high hardness, great resistance to cratering, and unusual strength can help you cut costs where fast, accurate work is essential. 93.2 Rockwell A hardness.



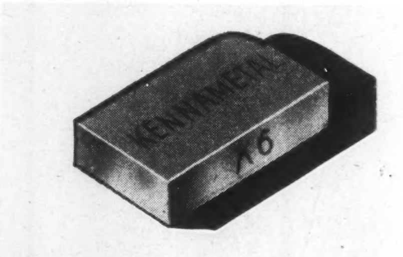
Strongest crater-resistant Kennametal tool material—saves tooling and production costs when taking rough cuts on carbon and alloy steel forgings, bar stock, etc., having carbon content of .30% and higher. Also outstanding for milling of steel at heavy chip loads. 91 Rockwell A hardness.



A very strong Kennametal tool material, particularly suitable for roughing cuts on steel castings. Its high resistance to abrasion and edge wear of sand inclusions makes possible exceptionally high rate production, and economical tooling costs. 91.5 Rockwell A hardness.



Highly resistant to edge wear—takes a good edge—a money-saving tool material for very light finishing cuts on steel and for precision boring with less than .004" feed. Ideally suited for tools requiring large nose radius or where tool must dwell without cutting. Excellent for milling, and very rough cutting of brass, bronze, and aluminum alloys. 92.3 Rockwell A hardness.



Reduces cost of machining cast iron. Extremely hard, straight tungsten carbide tool material having unusual strength. Holds keen edge, withstanding shock of interrupted cuts on rough, sandy, or chilled castings. Also outstanding for finishing and precision boring of cast iron. 92.2 Rockwell A hardness.

KENNAMETAL Blanks are now sold in *Economical* "Package Lots."
For Prices and Particulars Send for Catalog 46

TRADE MARK REG. U. S. PAT. OFF.

KENNAMETAL

SUPERIOR CEMENTED CARBIDES

KENNAMETAL *Inc.*, LATROBE, PA.

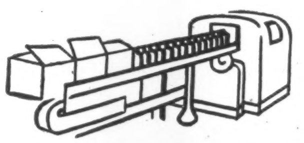
simplify THE APPLICATION OF HYDRAULIC ACTUATION TO ANY ONE OF THESE 4* PRODUCTS . . . .

ROAD MACHINERY

Where you need a compact economical unit for operations, such as positioning a blade, you'll find it in the elements listed below.

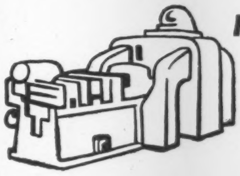
MATERIALS HANDLING EQUIP.

For fast snappy action in moving heavy loads quickly, and, accurate control for lifting to required heights, you'll find an economical solution in the Sundstrand standard hydraulic elements.



PACKAGING MACHINERY

You'll get variable speed control, accurate and fast control of movements and consistently accurate duplication of movement with the proper combination of standard Sundstrand hydraulic elements.



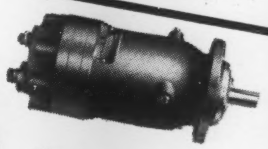
MACHINE TOOLS

Effective speed and feed controls and consistently accurate clamping pressures can both be obtained easily from a simple Sundstrand hydraulic circuit. Here, again, in the standard elements, illustrated below, you'll find what you need for better designing.

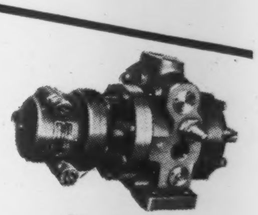
** Sundstrand hydraulic elements are widely used in hydraulic circuits in many similar products.*

. . . WITH THESE STANDARD SUNDSTRAND ELEMENTS

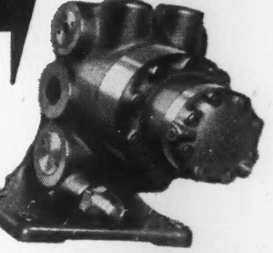
Yes, hydraulic circuits designed with the proper combination of these standard Sundstrand elements offers the best solution to your hydraulic equipment design problems. Proper combinations and circuit design are arrived at through design conferences between you and our hydraulic application engineers . . .When designing new equipment or redesigning present models, call in a Sundstrand hydraulic application engineer. He will suggest the best combination of these hydraulic elements to meet your design requirements . . . There is no obligation for this service.



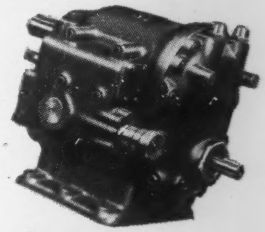
FLUID MOTORS



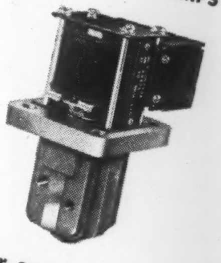
PUMPS



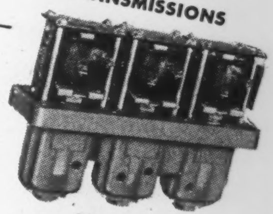
CLAMPING PUMPS



TRANSMISSIONS

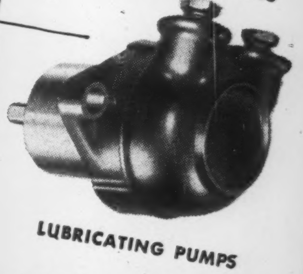


SINGLE SOLENOID VALVES

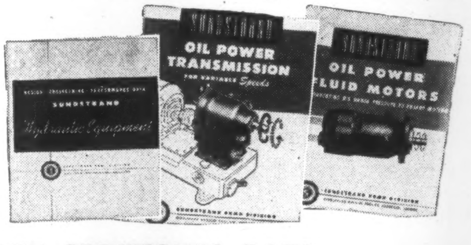


TRIPLE SOLENOID VALVES

FOUR-WAY VALVES



LUBRICATING PUMPS



FREE ADDITIONAL DATA is included in this set of bulletins. Write for your copies today. Ask for bulletin M-17

SUNDSTRAND MACHINE TOOL CO. ROCKFORD, ILLINOIS U.S.A.

SUNDSTRAND PUMP DIVISION

2559 ELEVENTH STREET • ROCKFORD, ILLINOIS

FUEL UNITS • HYDRAULIC PUMPS • TRANSMISSIONS • FLUID MOTORS • VALVES and CONTROLS

MORE FEET PER POUND
...that's Stainless Thinsteel
MORE PARTS PER TON
...that's Stainless Thinsteel
MORE "SELL" PER PRODUCT
...that's Stainless Thinsteel
...AND THE RECORDS PROVE IT

SALES RECORDS prove that the eye-appeal of rust-resistant and heat-resistant stainless steels means more buy-appeal. It gives your product that extra pull that keeps sales registers jingling. So for sales sake make it bright . . . make it light . . . make it with CMP Thinsteel.

PRODUCTION RECORDS prove that CMP Stainless Thinsteel results in impressive fabrication economies. Coil-after-coil dimensional accuracy . . . physical properties and chemistry just right for your specific requirements . . . exceptional quality finish . . . these advantages mean less down-time and longer die life. CMP Stainless Thinsteel is produced in gauges thin as .001″, in popular chrome and chrome-nickel grades, and in all tempers from dead soft to full hard.

WRITE or call CMP . . . today.

COLD FACTS ABOUT

STAINLESS THINSTEEL

- **EXTRA LONG COILS** *...less downtime*
- **EXTREMELY CLOSE TOLERANCES** *...more parts per ton*
- **WIDE RANGE OF PHYSICALS AND ANALYSES** *...tailored for your products*
- **GAUGES THIN AS .001″** *...strength with lightness*

CMP PRECISION COLD ROLLED STRIP STEEL THINSTEEL

GIVES MAXIMUM PRODUCTION PER TON

THE COLD METAL PRODUCTS CO.
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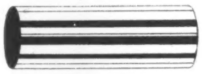
The Old Way

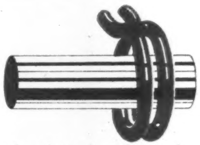


1 Start with 1⅝" round, 4½" long. Weight 2.64 lbs.

2 Stock: S. A. E. 1060 annealed for machinability.

3 Machine to 1.3780" diameter, except shoulder 3/32" wide and .111" high. .736 lb. of metal removed.

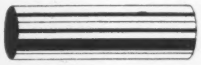
4



5 Induction harden shoulder to Rockwell C 62.

6 Grind shaft both ends.

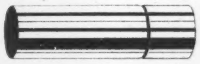
with RELIANCE RINGS



1 Start with 1.3780" round, 4½" long. Weight 1.89 lbs.

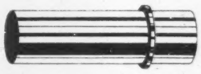
Saving .75 lb.

2 Stock: S. A. E. 1060, turned and ground.



3 Machine groove .105" wide and .045" deep. Approximately .004 lb. of metal removed. .732 lb. less metal to remove.

Note saving of machining.



4 Assemble ring in groove.

A simple operation.

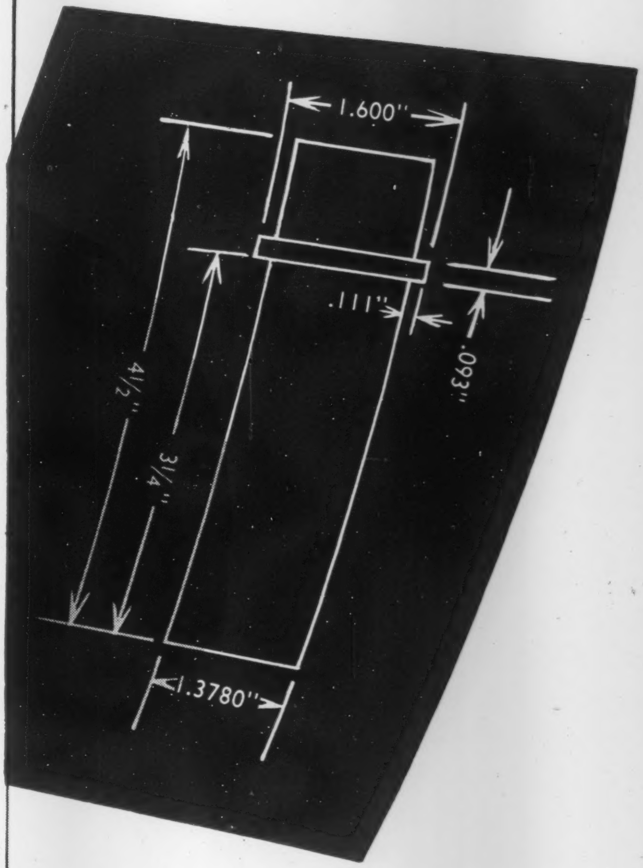
5 Ring already hardened.

No heat treating necessary.

6 Shaft already ground.

No grinding necessary.

Assembly has ultimate shear strength of 37,000 lbs., when snap ring and shaft are of the same hardness. Will withstand pressures in excess of 5000 lbs.



are there any *Savings like this* in your product?

The illustration shows a common cost-cutting application of Reliance Rings in the production of shouldered shafts. They may also be used to produce shoulders in bores.

Made from carbon, alloy or stainless steel, or non-ferrous metal to specified physicals . . . of any desired cross section and diameter . . . welded or open with ends shaped to meet any requirement . . . Reliance Rings offer limitless possibilities for reducing costs, speeding production and improving product performance.

Folder 43 offers many helpful suggestions for the profitable application of Reliance Snap Rings on products of all kinds. Write for a copy.

RELIANCE SPRING LOCK WASHERS

in American Standard sizes — compensate for looseness of bolted parts. Keep bolted assemblies tighter longer.

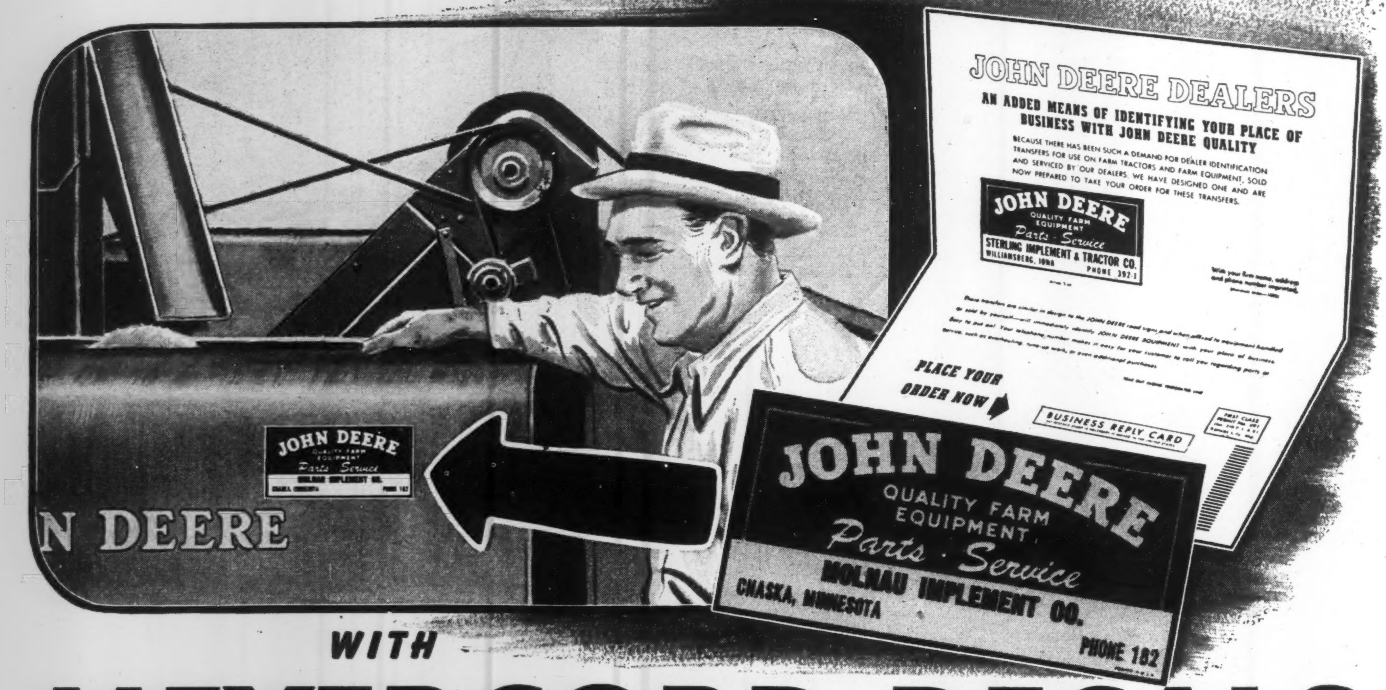
EATON SPRINGTITES

The all-in-one unit, quality spring lock washer pre-assembled on a bolt or screw. Cuts production cost by increasing production efficiency.

EATON
EATON MANUFACTURING COMPANY

Reliance Division
OFFICES AND PLANT **MASSILLON, OHIO**
Sales Offices: New York • Cleveland • Detroit • Chicago • St. Louis • San Francisco • Montreal

HOW JOHN DEERE SOLVED THE PROBLEM OF THE ANONYMOUS DEALER...


JOHN DEERE
QUALITY FARM EQUIPMENT
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PLACE YOUR ORDER NOW
BUSINESS REPLY CARD

JOHN DEERE DEALERS

AN ADDED MEANS OF IDENTIFYING YOUR PLACE OF BUSINESS WITH JOHN DEERE QUALITY

BECAUSE THERE HAS BEEN SUCH A DEMAND FOR DEALER IDENTIFICATION TRANSFERS FOR USE ON FARM TRACTORS AND FARM EQUIPMENT, SOLD AND SERVICED BY OUR DEALERS, WE HAVE DESIGNED ONE AND ARE NOW PREPARED TO TAKE YOUR ORDER FOR THESE TRANSFERS.

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STERLING IMPLEMENT & TRACTOR CO.
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WITH

MEYERCORD DECALS

YOUR DEALER'S NAME ON *YOUR* PRODUCT HELPS HIM MAKE MORE SALES

Most consumers buy durable goods from dealers . . . not manufacturers. When the need for service, parts or re-purchase occurs, it isn't the distant factory but the dealer who gets the call.

Manufacturers can provide pool-purchased standard, personalized dealer Decal nameplates to their outlets at a saving of 80% over former prices . . . and at no cost to themselves.

Today . . . combination "factory-dealer" Decal nameplates link John Deere's trademark with their dealer's name, address and phone number on the equipment they sell. Formerly a few scattered dealers bought their own Decal nameplates. Relatively high cost of small individual dealer purchases limited the practice to only the largest. There was no uniformity of design. Nameplates varied with each dealer. Few included the manufacturers' name.

Pooled factory buying, stimulated by direct mail to dealers, now enables John Deere to sell a standard, personalized Meyercord Decal dealer nameplate to their outlets at a fifth of the former cost. It costs the factory nothing—saves the dealer 80%.

Whether you make farm equipment, stokers, lawnmowers, electric appliances or what—the problem's the same. Of course your product is factory identified—but what about the dealer? Is he *anonymous?* Assure ease and speed of dealer contact for your ultimate consumer with a standard, personalized factory-controlled Meyercord Decal dealer nameplate program for *your product.* Meyercord Decals are durable, easily applied and can be produced in any colors, size or design. Send for complete "dealer identification" details. Address Dept. 15-6.

NOTE: *The big, colorful, weather-resistant Decal trademarks you see on leading makes of farm equipment today are made by Meyercord.*

Founder-Member Lithographic Technical Foundation

The MEYERCORD Co.
World's Largest Decal Manufacturer
5323 W. LAKE ST. CHICAGO 44, ILL.

INTERNATIONAL HARVESTER
SERVICED BY
MOUNT MORRIS ELEVATOR CO.
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CASE
Parts and Service

International Harvester, Oliver and J. I. Case solve the problem of the "anonymous dealer" with pool-purchased standardized dealer Decal nameplates, too!

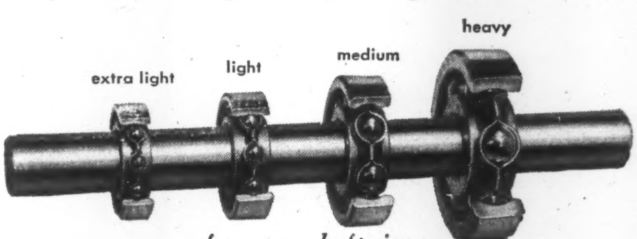
ADVERTISE • IDENTIFY • DECORATE . . . WITH MEYERCORD DECALS

HOW THIN CAN YOU SLICE A BALL BEARING?

HOW MUCH STEEL do you have to have around the balls in a ball bearing to do the job you're buying it for? That's a lot bigger than any $64 question to any manufacturer who's out to keep his product competitively light, compact and economical.

Fafnir's got the answer . . . a whole series of answers. They've been working on this question for years . . . slicing off excess weight, useless bulk, unnecessary cost. They've developed series after series of bearings . . . to carry ton loads or to transmit the impact of a cat's whisker . . . to handle the terrific peripheral speeds of modern machine tool spindles or to glide gently at the touch of a finger.

That's Fafnir's job . . . to help you get all the ball bearing smoothness and stamina you need at the lowest price in pounds, inches and dollars. There's a Fafnir engineer ready to go to work with you on your new machine or equipment. The Fafnir Bearing Company, New Britain, Conn.



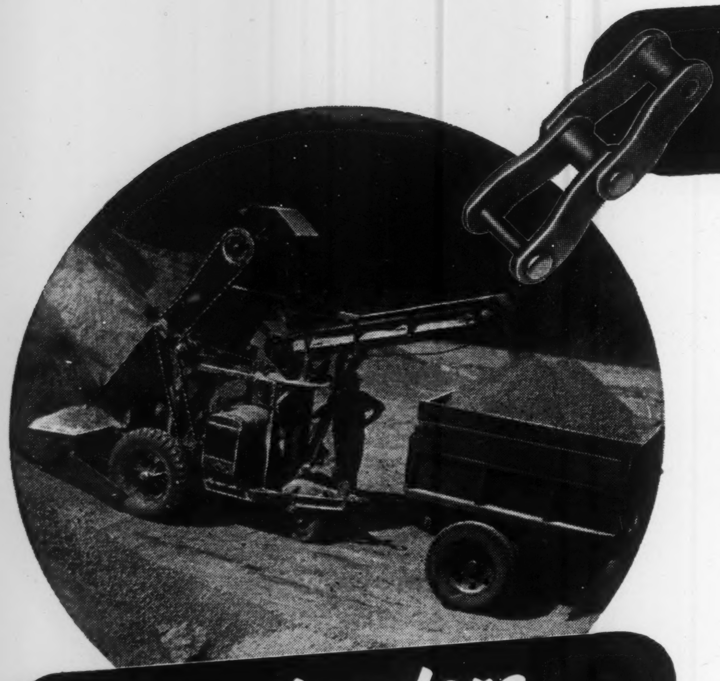
for same shaft size

FAFNIR **BALL BEARINGS**

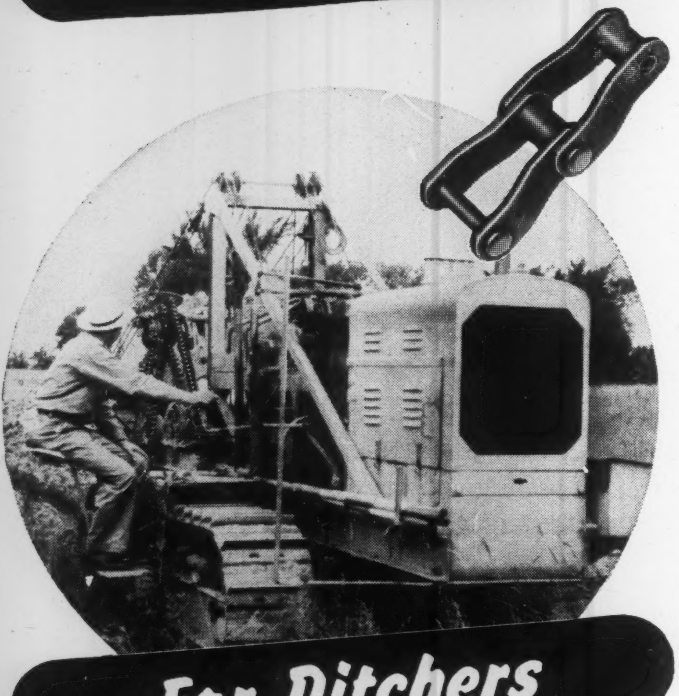
MOST COMPLETE LINE IN AMERICA

When you need

Specify REX Chabelco!



For Loaders



For Ditchers

Rex Chabelco Steel Chain is extra tough . . . *extra* rugged for the roughest type of drive and conveyor service. It's built to give you the added strength you want in your designs . . . to assure the dependable, economical service that adds to product salability.

Each part of Rex Chabelco Chain is precision built to exacting specifications. It combines relative light weight with high strength. Hardened wearing surfaces assure unusual lasting qualities under the most severe service conditions.

Rex Chabelco Drive Chains are used where greater strength, higher speed and long life at high speeds are required, such as for drill-

REX CHAIN BELTS

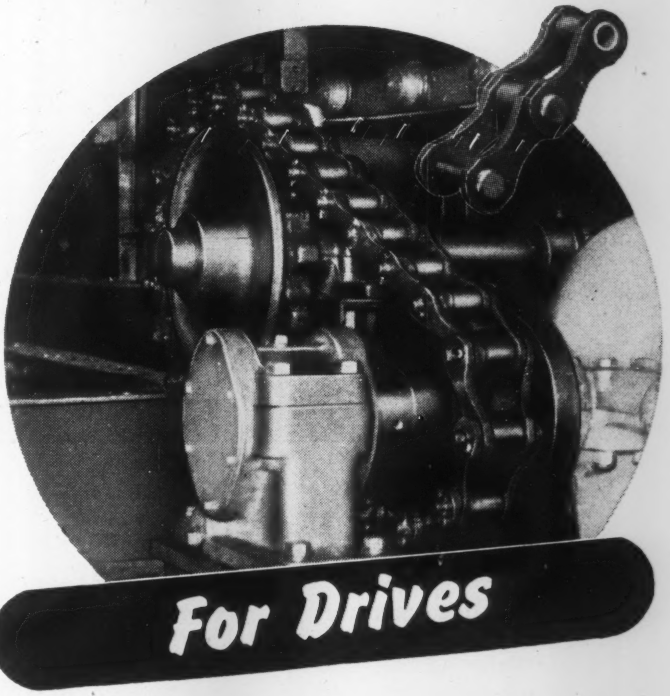
a chain with EXTRA Strength..

For Shovels

ing rigs, construction equipment, heavy conveyor drives, etc.

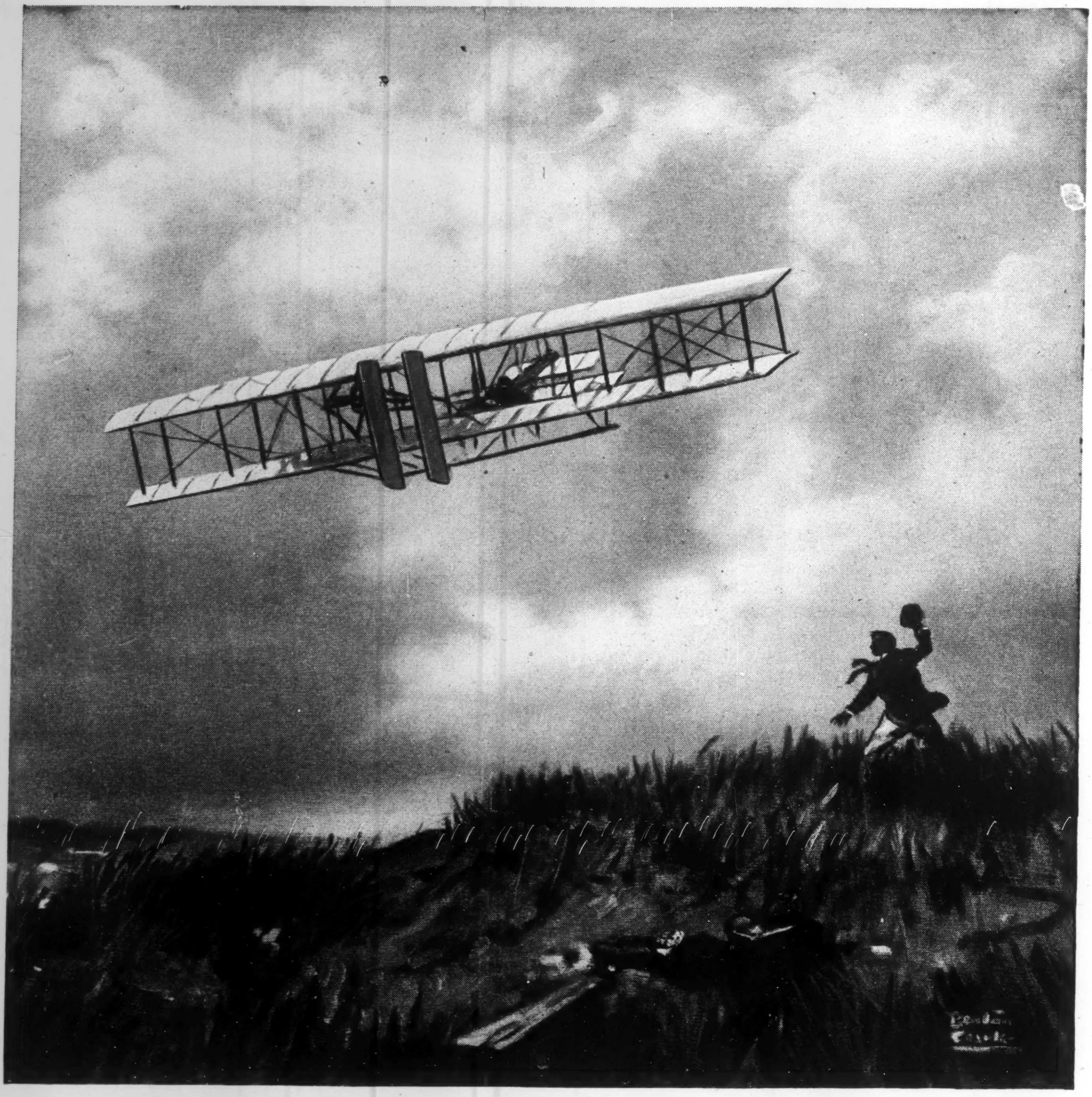
Rex Chabelco Conveyor Chains are made in both offset side bar and straight side bar types and are used in conveyors where loads are heavy, centers long and service severe. Typical applications are in ovens, assembly conveyors, elevators, bottle washers and pasteurizing machines, pipe mills, steel mills, and many others. Standard attachments are available to answer virtually all conveying needs.

For all the facts and for application assistance, see your Rex Man or write direct to Chain Belt Company, 1643 West Bruce Street, Milwaukee 4, Wisconsin.



For Drives

·CHAIN BELT COMPANY
of Milwaukee . . . . .



He flew through the air with the greatest of difficulty

Along the lonely Carolina shore at Kitty Hawk one winter day in 1903 a powered heavier-than-air "flying machine" took off from a greased rail. Its engine rested on its lower wing and beside the engine lay the pilot, Orville Wright, with controls hitched to his shoulders. In this fashion he "flew" about 120 feet while his brother Wilbur stood by watching.

The aviation industry, which was born that day, soon took on anti-friction bearings as standard equipment, and SKF led in the development of these bearings.

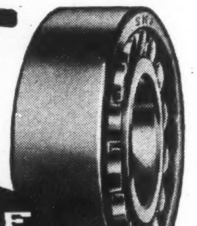
During the war SKF turned out millions of bearings for fighting aircraft, bearings for high powered engines as well as gas turbines for jet propulsion, and many types of ultra high-precision bearings used in air distance recorders, turn and bank indicators, tachometers and many other delicate instruments.

The services of the SKF Engineering Department and Research Laboratory are available to all who may need help in selecting . . . .

THE RIGHT BEARING FOR THE RIGHT PLACE

SKF

BALL AND ROLLER BEARINGS



SKF Puts the RIGHT BEARING in the RIGHT PLACE

7009A

SKF INDUSTRIES, INC., PHILA., PA.

WHERE THERE'S A WILL
there's a way
TO CUT COSTS *with*
FORMETAL *Superformed* BUSHINGS AND BEARINGS

If you are really trying to cut costs and improve performance at the same time, specify FORMETAL. Through the exclusive qualities of these bushings and bearings, you can produce savings in materials and in operating costs.

For example, in a FORMETAL Bushing you can use a thinner wall to provide the same strength as the thick wall of an ordinary bushing. You can select a higher Rockwell hardness without loss of machinability. You can have a custom-made oil groove, vital to long, smooth performance, engineered to your particular need.

Yet with these and many other advantages, FORMETAL bushings and bearings, whether made of bronze, steel, or alloy to your specification, *cost you no more than ordinary types.* If you are an engineer or buyer of bushings, bearings, or spacer tubes, write for the free new catalog. You'll want it for constant reference!

To get your products really rolling . . . use FORMETAL!

NATIONAL FORMETAL CO., INC.
ESTABLISHED 1919
Manufacturers of "Superformed" Bushings and Bearings . . . and Spacer Tubes
6604 METTA AVENUE • CLEVELAND 14, OHIO
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This is a
LEATHER
GASKET

It will insure positive sealing, maximum resistance to pressures and temperatures, remain impervious to contacting fluids, and withstand frictional wear. Sirvis engineers will design special washers from selected leather, tanned and treated to the right degrees of hardness and resilience, cut on precision dies and leveled to the exact thickness demanded by your specifications.

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Products of

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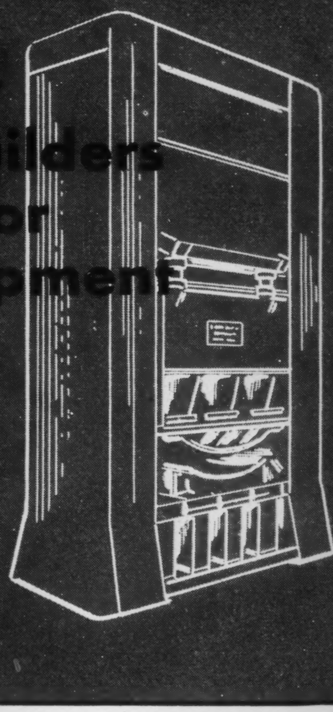
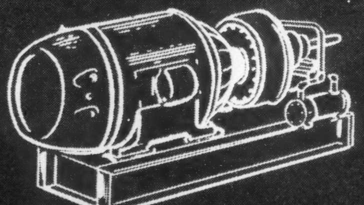
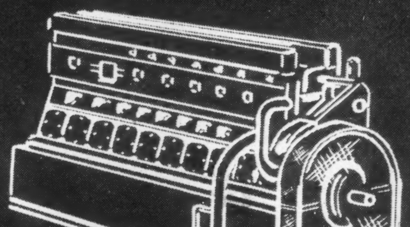
Some very important reasons...

why so many Machinery Builders select ROSS for Original Equipment



ROSS "BCF" COOLERS





Machinery builders show a heavy preference for the Ross "BCF" design for cooling oil, water and other fluids up to 250 GPM. Accordingly, a high percentage of Diesels, compressors, hydraulic presses, torque converters, reduction gears and turbines includes this Ross cooler as original equipment.

Why Ross? Why the "BCF"? For the same reasons that thousands of *USERS* have made this selection for many, many years:

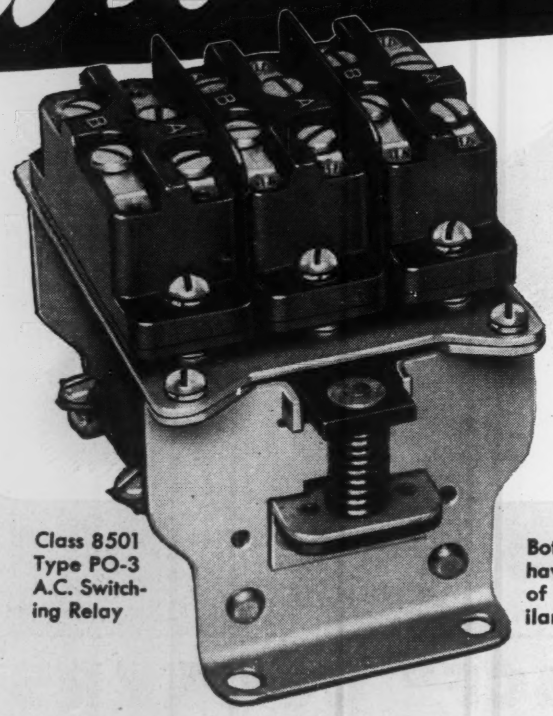
- *Small, light weight, compact.*
- *Strong, durable, corrosion resistant.*
- *Made entirely of non ferrous materials.*
- *High heat transfer rate.*
- *Features adaptable to individual needs.*
- *Easily inspected and cleaned.*
- *Simple to install.*

FREE ON REQUEST
Complete details in Bulletin 4922. Write on your Company letterhead.

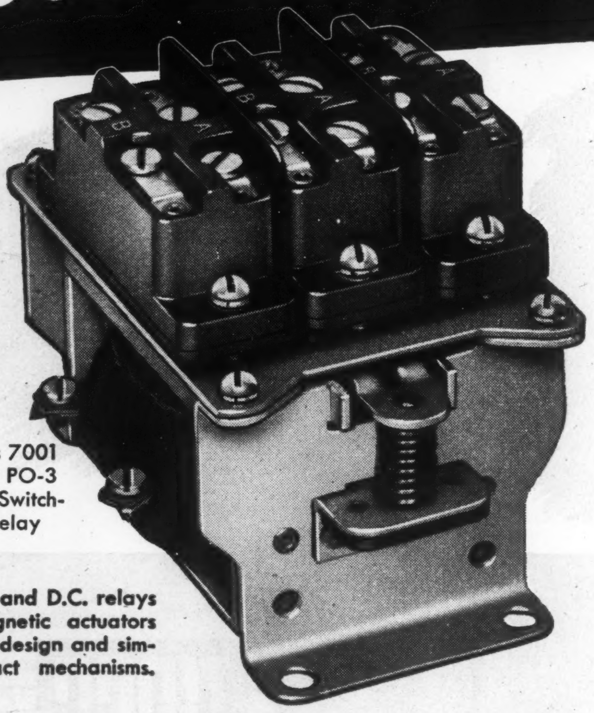
ROSS HEATER & MFG. CO., INC.
Division of AMERICAN RADIATOR & Standard Sanitary CORPORATION
1429 WEST AVE. BUFFALO 13, N. Y.

Ross equipment is manufactured and sold in Canada by Horton Steel Works, Ltd., Fort Erie, Ontario

a New Idea in A.C. and D.C. Switching Relays



Class 8501
Type PO-3
A.C. Switching Relay



Class 7001
Type PO-3
D.C. Switching Relay

Both A.C. and D.C. relays have magnetic actuators of similar design and similar contact mechanisms.

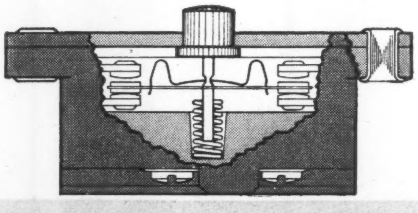
APPLICATION • Switching relays are used to set up complicated control circuits, pilot larger contactors or motor starters, energize pilot lights or audible signals, isolate low voltage control circuits and occasionally to start or stop very small motors having integral overload protection.

CHARACTERISTICS • They must be extremely compact, relatively inexpensive, rapid in response, dependable over long periods of operation, flexible, easily installed, and have comparatively low magnet coil demand.

SQUARE D's DESIGN has all these desirable characteristics. It is mounted and wired from the front and requires no extra space for electrical or mechanical clearances; is made up of standard parts; has short stroke and straight line action; utilizes one, two or three individually-enclosed snap-action contacts of double-throw construction; can be readily converted to meet job requirements; comes with either A.C. or D.C. magnetic actuators of similar design. Relays are furnished either open-type or in a NEMA Type I general-purpose enclosure.

CONTACT MECHANISM CONSTRUCTION

Simple operating mechanism with alloy leaf springs separate from contact blade . . . Stainless steel compression-return spring . . . Husky case of highly arc-resistant melamine . . . Separate normally-open and normally-closed circuits with double-break silver contacts . . . Four No. 6-32 binder-head terminal screws.

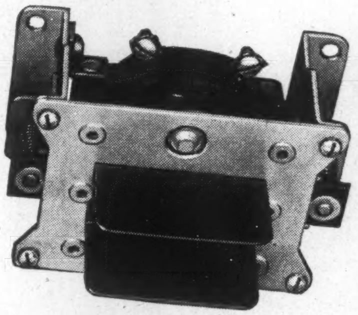


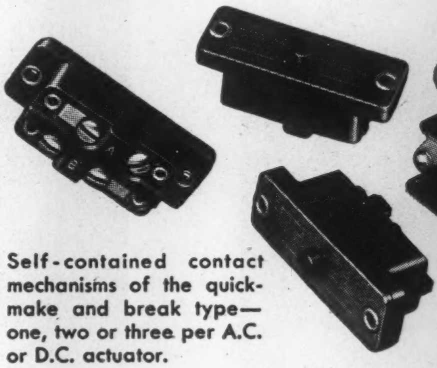
SQUARE D COMPANY

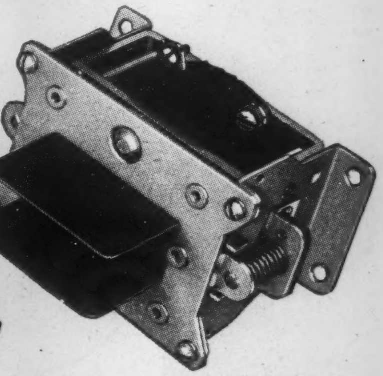
DETROIT • MILWAUKEE • LOS ANGELES

Using a magnetic actuator with one or more self-contained contact mechanisms of the quick-make and break type

PART OF THE PARADE OF NEW DESIGNS


A.C. Magnetic Actuator with contact mechanisms removed.


Self-contained contact mechanisms of the quick-make and break type—one, two or three per A.C. or D.C. actuator.

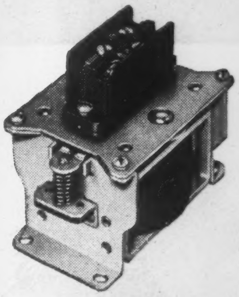

D.C. Magnetic Actuator interchangeable in mounting with A.C.

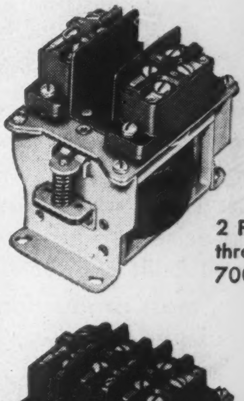
Flexibility

is a characteristic of growing importance in the field of automatic control. Use of an A.C. or D.C. magnetic actuator of similar design with one, two or three self-contained contact mechanisms, each having one normally-open and one normally-closed contact, results in a switching relay to meet nearly all requirements. Actuators (carried in stock) with only one contact mechanism, may be readily converted to additional poles by installations of either one or two additional standard contact mechanisms, also from stock. Contact mechanisms are easily and quickly renewed in the field with a minimum of expense.

CONTACT RATINGS

	A.C. Voltage				D.C. Voltage		
Electrical Ratings	110	220	440	550	115	230	550
Normal Amperes	15	10	6	5	2	0.5	0.1
Inrush Amperes	40	20	10	8	—	—	—

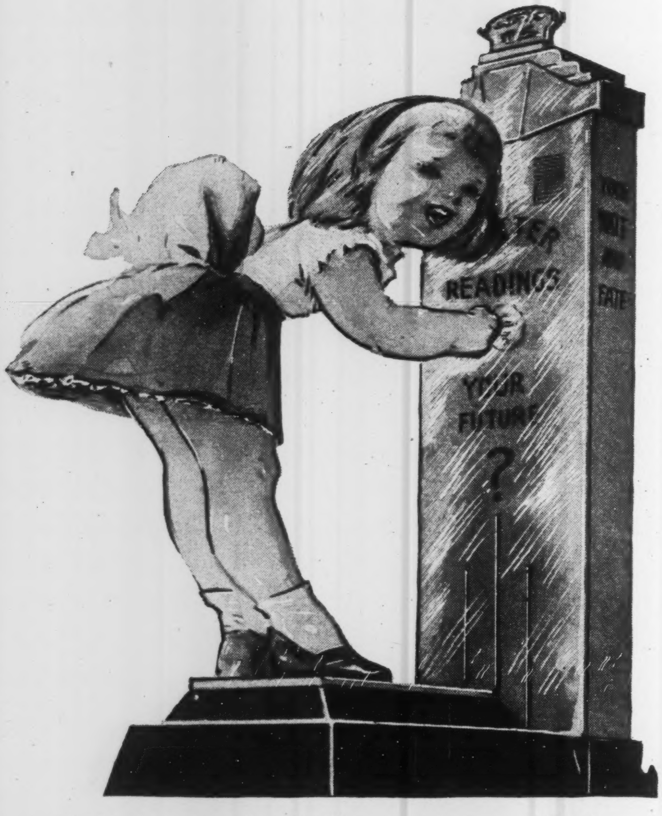

1 Pole, Double throw, D.C. Class 7001 Type PO-1

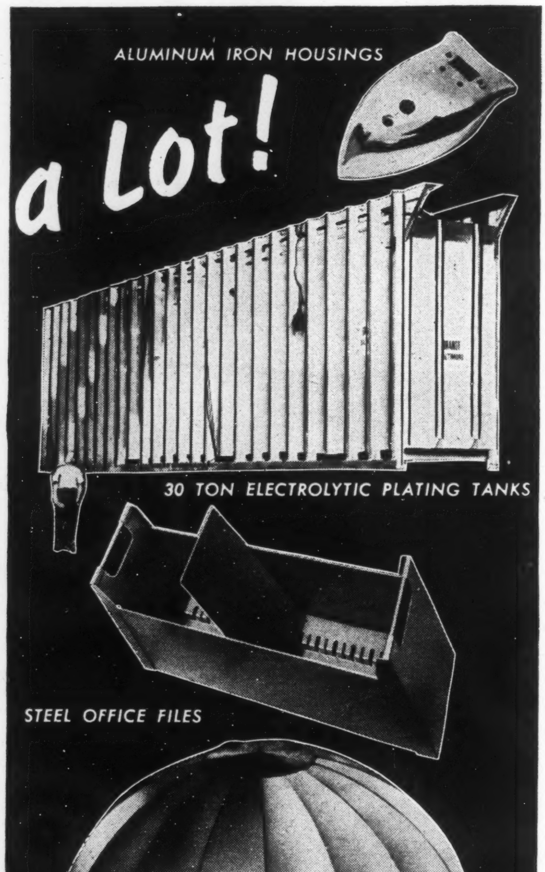

2 Poles, Double throw, D.C. Class 7001 Type PO-2

3 Poles, Double throw, D.C. Class 7001 Type PO-3

Write **for complete details on Type P Switching Relay. Address SQUARE D COMPANY, 4041 N. Richards Street, Milwaukee 12, Wisconsin. Or ask your nearby Square D Field Engineer.**

When a Penny Weighs a Lot!

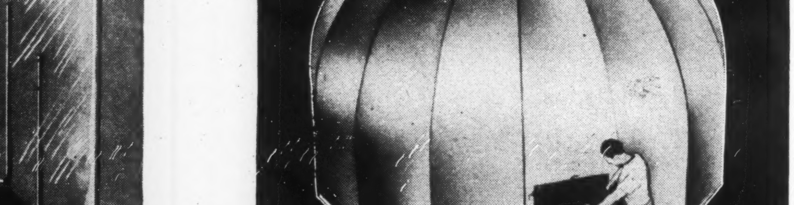

WEIGHT
READINGS
YOUR FUTURE
?
YOUR WEIGHT AND FATE


ALUMINUM IRON HOUSINGS
30 TON ELECTROLYTIC PLATING TANKS
STEEL OFFICE FILES
PROTECTIVE NAVAL GUN HOUSINGS
COPPER TANKS (HYDROLIZING)

A penny's worth of small precision mechanism please! Thrown into instant accurate operation are all parts in the scale when the little lady drops her penny into the slot. These small scales made at Brandt bear the same precise workmanship as heavy industry's largest Brandt built products.

Specialized mass production facilities and the quality of the finished job are always at the same high level. If your problem is in steel or non-ferrous metals Brandt will turn out a product worth much more than its weight in quality and precision.

Scales: American Scale Manufacturing Co.



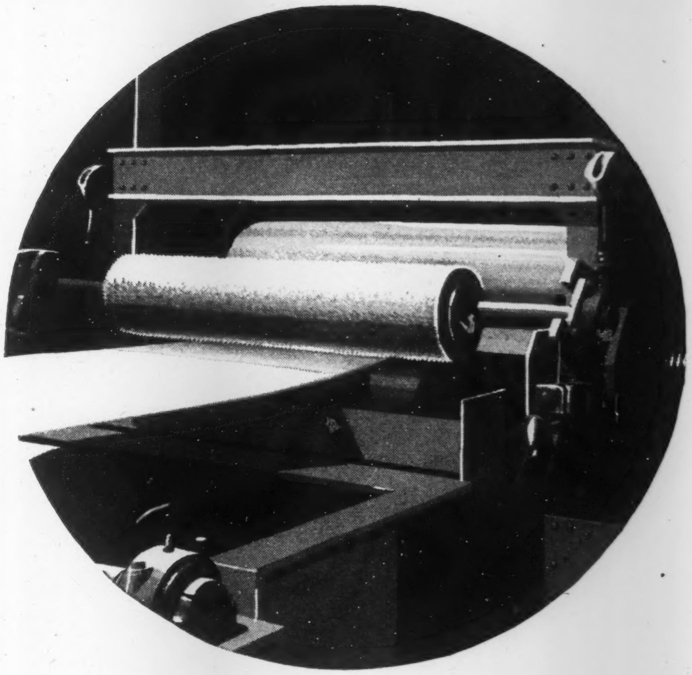
ALL UNDER ONE ROOF
In the midst of major rail, water and highway transportation facilities.

BRANDT
BALTIMORE

CHARLES T. BRANDT, INC., 1700 RIDGELY ST., BALTIMORE-30, MD.

57 Years of *Specialized* Metal Working Experience

Every "Brush-off" has a Silver Lining!



● To change a #4 abrasive belt finish on stainless steel sheets to a perfect #6 satin finish, calls for a special power-driven brush. Pittsburgh has such a brush and its efficiency has been tested and proved by leading strip producers. ● Dense filled, medium stiff tampico brushes are used with light contact, motivating the abrasive on the steel sheets. This action prevents scratching and produces a clear, uniform surface. ● With uniform density of fill and even trim, they are built for long periods of dependable service. They can be statically balanced after being made, if required.

Why the Pittsburgh Plate Glass Company Makes Brushes

As a leading manufacturer of paints, Pittsburgh found that a reliable source of quality brushes was necessary for the proper application of its products. For over 40 years, Pittsburgh has made its own paint brushes. It was a natural step to extend its engineering and manufacturing facilities by developing production, maintenance and power-driven brushes engineered to the specific needs of industry, since many types of power-driven brushes are employed in our own production processes.

Finish up with a Pittsburgh Power-Driven Brush

● A Pittsburgh Brush does the job fast and gives you a uniformly finished product. You can depend on Pittsburgh Brushes for better performance, enduring economy, and a minimum of lost time in changeovers. In the complete Pittsburgh line are brushes of all types, including "Perfect Balance" sections, wheels and section assemblies, Uni-Fill scratch brushes, as well as paint and other maintenance brushes. ● Consult with the Pittsburgh engineering representative. He will gladly work with you in developing any type of power-driven brushes to meet your particular finishing requirements.

PITTSBURGH
PLATE GLASS COMPANY *Brush Division*
3221 FREDERICK AVENUE · BALTIMORE—29 · MARYLAND

UNBRAKO

Reg. U. S. Pat. Off.

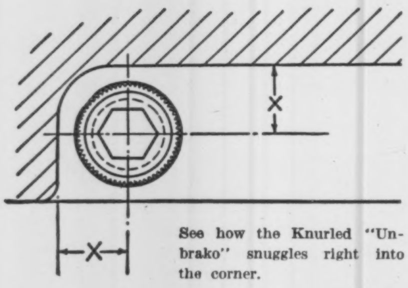
Knurling of Socket Screws originated with "Unbrako" in 1934.

KNURLED
SOCKET HEAD CAP SCREWS

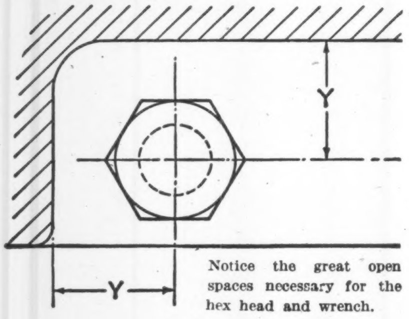
prevent lost motion therefore save assembly time

They speed assembly because their knurled heads provide a slip- and fumble-proof grip—be the fingers and head ever so oily—therefore, they can be screwed-in faster and farther before it becomes necessary to use a wrench. Their internal wrenching feature facilitates compact designs, so space and weight are saved and cost reduced. Millions upon millions of these time-savers—in sizes from #4 to 1½" in diameter and in a full range of lengths—are being used throughout industry. Write for the "Unbrako" Catalog.

"Unbrako" and "Hallowell" Products are sold entirely through Industrial Distributors.



See how the Knurled "Unbrako" snuggles right into the corner.



Notice the great open spaces necessary for the hex head and wrench.

OVER 44 YEARS IN BUSINESS

"UNBRAKO" SOCKET SET SCREW WITH KNURLED CUP POINT

The knurled cup point of this "Unbrako" makes it a Self-Locker—the points dig in and hold fast, even when subjected to the most chattering vibration.

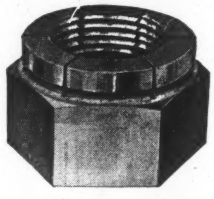
PAT'D AND PATS. PEND.

"UNBRAKO" SOCKET SET SCREW WITH KNURLED THREADS

Knurling the "Unbrako" Socket Set Screw, as shown, swages the threads and an excellent Self-Locker is the result—For use where the points such as: flat, dog, cone and oval do not lend themselves to knurling.

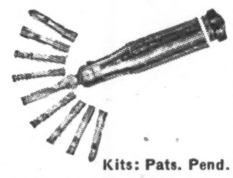
PAT'D AND PATS. PEND.

"FLEXLOC" SELF-LOCKING NUTS



The All-Metal, One-Piece "Flexloc" is a Self-Locking Nut that won't budge, except when a wrench is used. Every thread—takes its share of the load and being a "stop" nut it will stay locked in any position on a threaded member—"a real fastener", if ever there was one. Free samples.

"HALLOWELL" KEY KIT



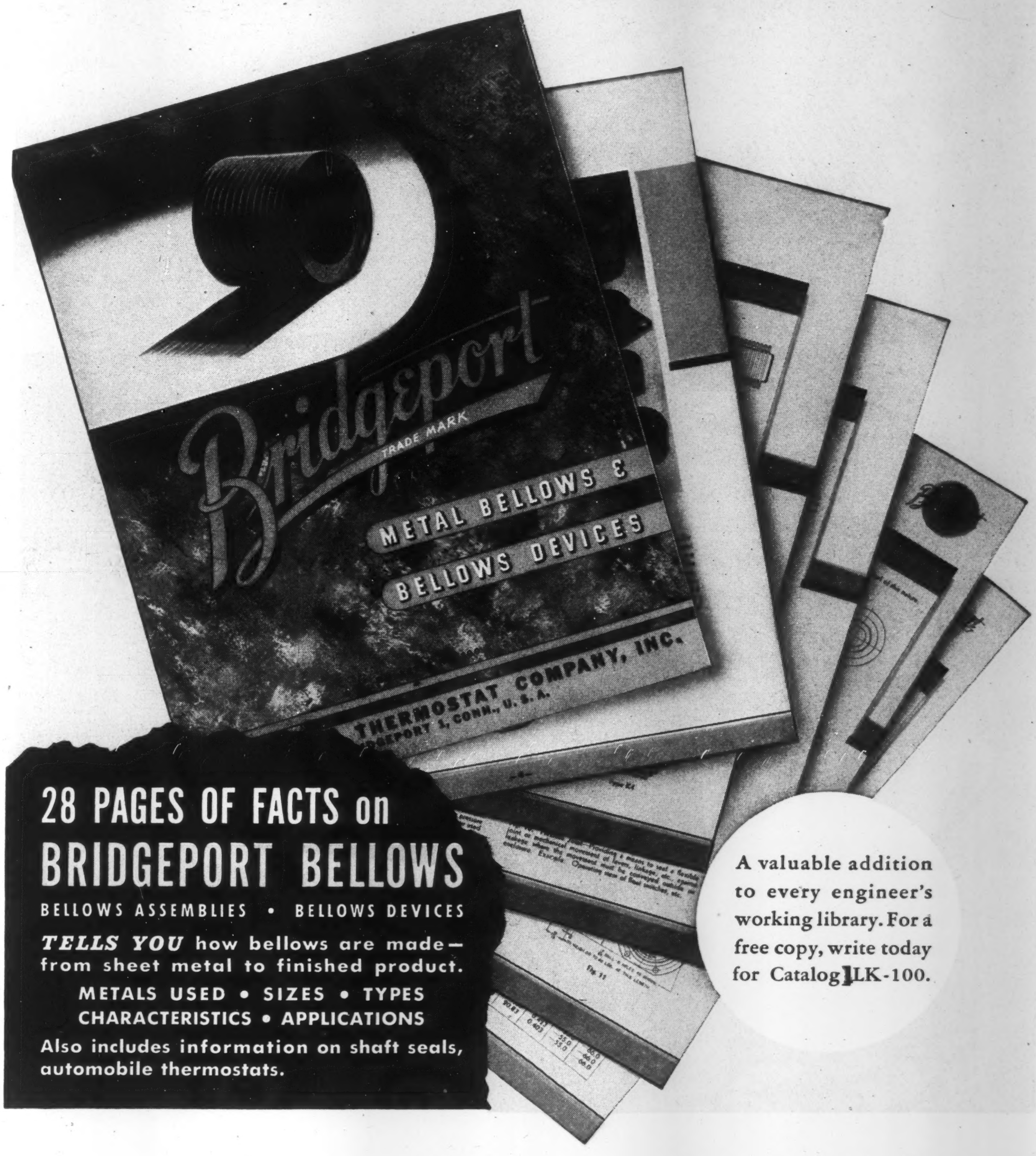
Kits: Pats. Pend.

You can't screw socket screws in or out without a hex socket wrench, so why not get our No. 25 or No. 50 "Hallowell" Hollow Handle Key Kit which contains most all hex bits.

STANDARD PRESSED STEEL CO.

JENKINTOWN, PENNA., BOX 102 · BRANCHES: BOSTON · CHICAGO · DETROIT · INDIANAPOLIS · ST. LOUIS · SAN FRANCISCO

COMPLETE • CONCISE • AUTHORITATIVE


Bridgeport
TRADE MARK
METAL BELLOWS &
BELLOWS DEVICES
THERMOSTAT COMPANY, INC.
BRIDGEPORT 1, CONN., U. S. A.

28 PAGES OF FACTS on BRIDGEPORT BELLOWS

BELLOWS ASSEMBLIES • BELLOWS DEVICES

TELLS YOU how bellows are made—from sheet metal to finished product.

METALS USED • SIZES • TYPES
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Also includes information on shaft seals, automobile thermostats.

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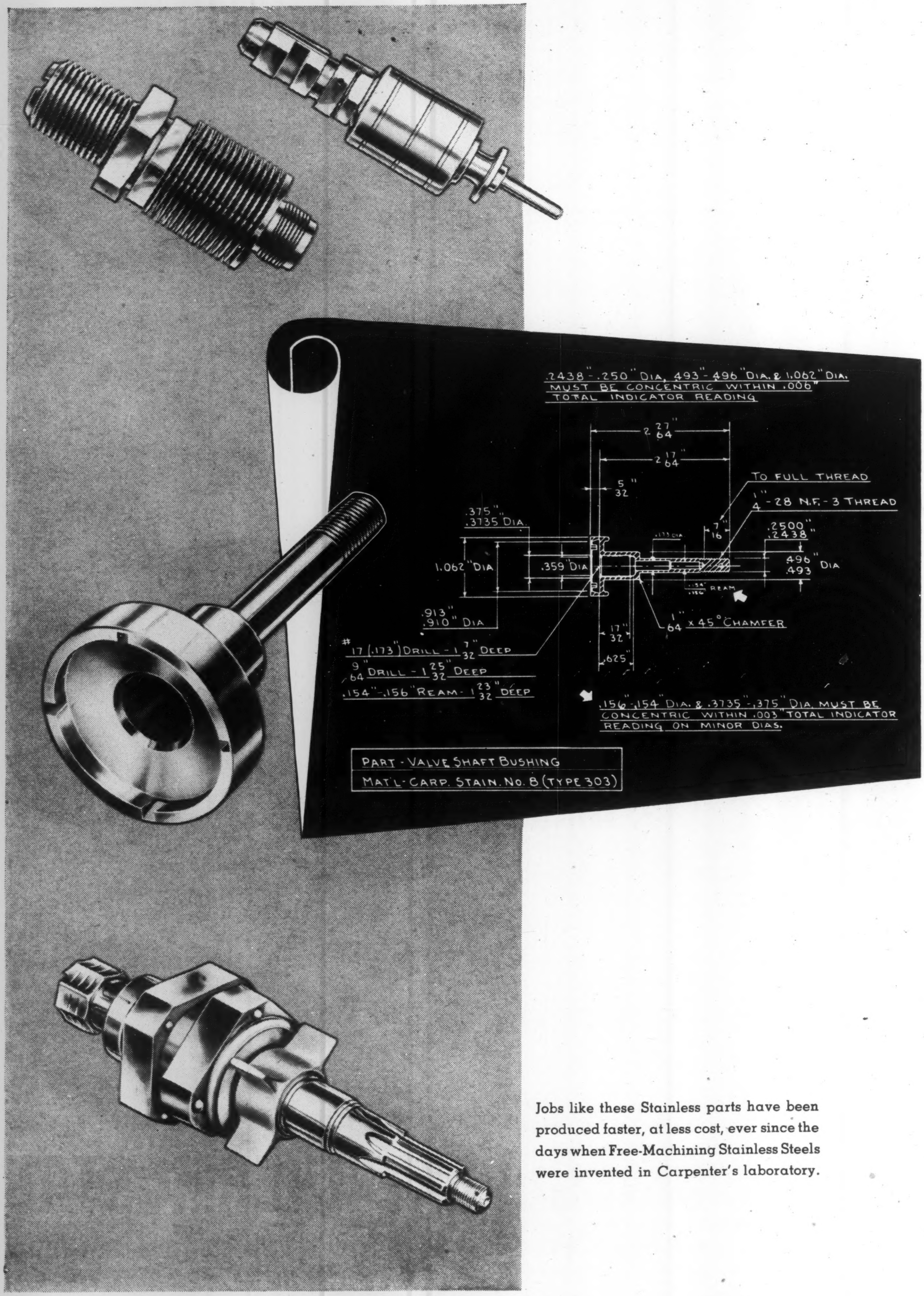
BRIDGEPORT THERMOSTAT
COMPANY, Incorporated • Bridgeport 1, Conn.


.2438"-.250" DIA, .493"-.496" DIA. & 1.062" DIA. MUST BE CONCENTRIC WITHIN .006" TOTAL INDICATOR READING
2 27/64"
2 17/64"
5/32"
TO FULL THREAD
1/4"-28 N.F.-3 THREAD
.375" .3735 DIA.
7/16"
.173 DIA
.2500" .2438"
1.062" DIA
.359" DIA
.496" .493 DIA
.154" .156" REAM
.913" .910" DIA
1/64" x 45° CHAMFER
17/32"
.625"
#17 (.173") DRILL - 1 7/32" DEEP
9/64" DRILL - 1 25/32" DEEP
.154"-.156" REAM - 1 23/32" DEEP
.156"-.154" DIA. & .3735"-.375" DIA. MUST BE CONCENTRIC WITHIN .003" TOTAL INDICATOR READING ON MINOR DIAS.
PART - VALVE SHAFT BUSHING
MAT'L - CARP. STAIN. NO. 8 (TYPE 303)

Jobs like these Stainless parts have been produced faster, at less cost, ever since the days when Free-Machining Stainless Steels were invented in Carpenter's laboratory.

One of the best ways we know to keep unit costs in line on Stainless machining jobs is to *combine uninterrupted production with consistently good finishes.*

And that means every operation must run smoothly from beginning to end—whether you're turning, drilling, tapping, threading, milling, broaching or reaming Stainless. It means you are aiming for fewer rejects on each inspection. To put yourself on the way to lower unit costs with Stainless, take these two steps now.

1. First, lower costs with Stainless depend to a great extent upon the Stainless you use. Absolutely uniform Stainless bars are the only kind that will really flow through your machines, keep you free from costly tooling troubles. And *uniformity* is just what you get with Carpenter Free-Machining Stainless—bar after bar, lot after lot. So specify *Carpenter* on every order for Free-Machining Stainless bars.

how to get HIGH PRODUCTION and GOOD FINISHES on Stainless Machining Jobs....

2. Take full advantage of the accurate and useful information that Carpenter has developed through years of experience with Stainless machining jobs. You'll find a lot of that experience in the "Notebook On Machining Stainless Steels"—available to Production and Management executives from the offices listed below. If you would like a personal copy, call your Carpenter representative. Extra copies of the NOTEBOOK for the men in your plant are available at 50¢ apiece.

THE CARPENTER STEEL COMPANY, 120 W. BERN STREET, READING, PA.

Carpenter

FREE-MACHINING

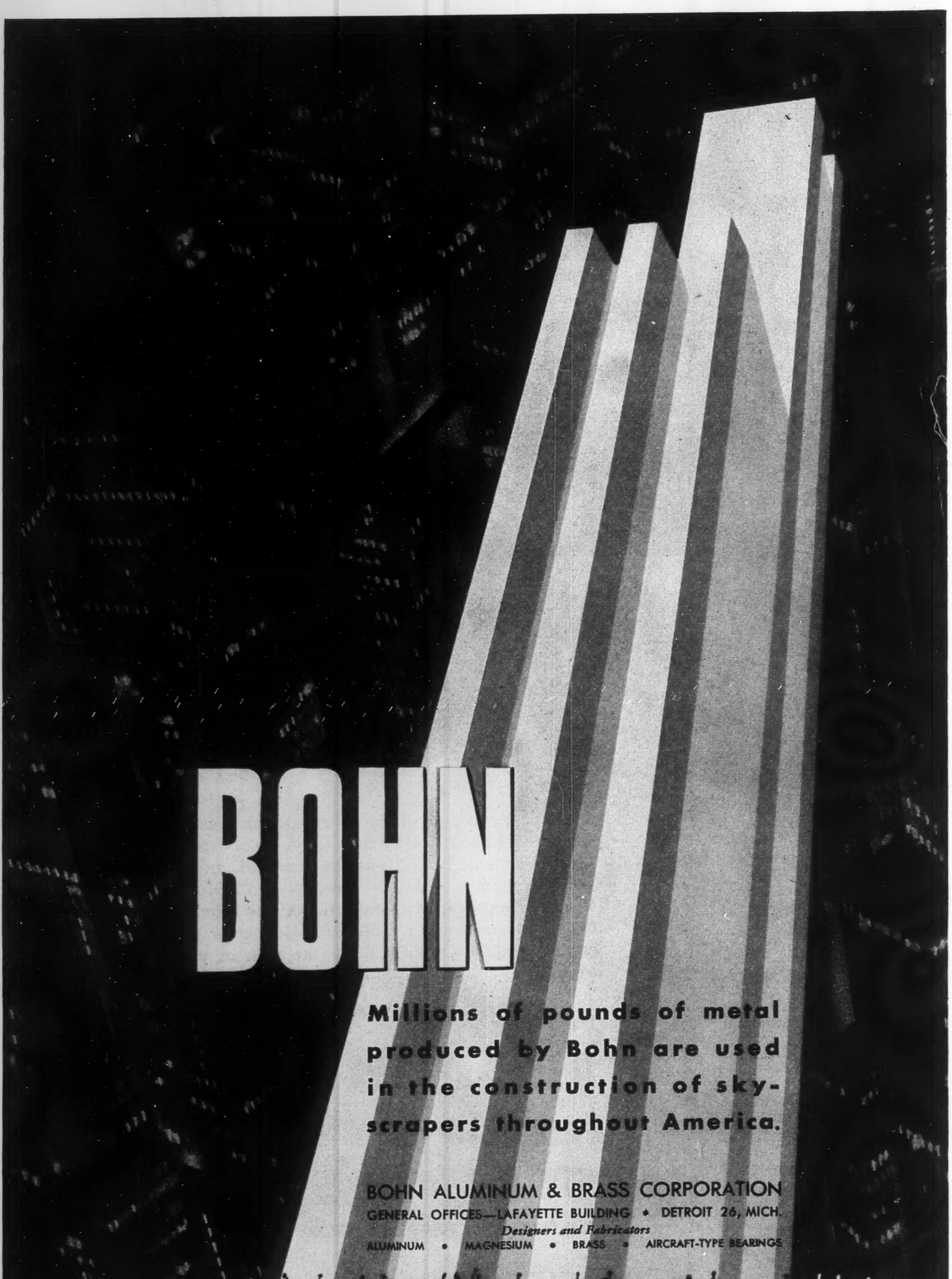
STAINLESS STEELS

more than corrosion resistance

CALL TODAY FOR PROMPT SHIPMENT FROM CONVENIENTLY LOCATED STOCKS

Baltimore Boston Buffalo Chicago Cincinnati Cleveland
Dayton Detroit Hartford Indianapolis Los Angeles
New York Philadelphia Providence St. Louis Worcester, Mass.

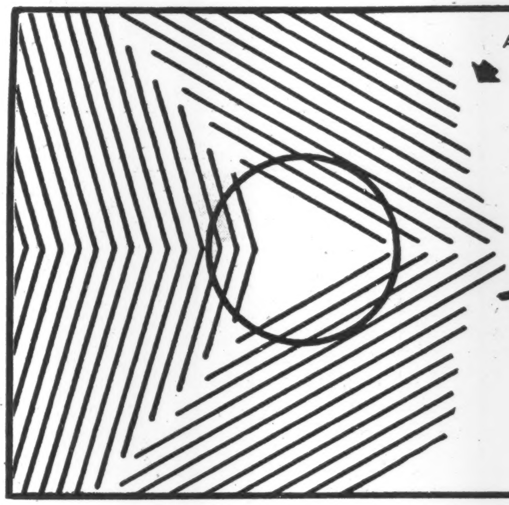
SEE THE CLASSIFIED SECTION OF YOUR TELEPHONE DIRECTORY



BOHN

Millions of pounds of metal produced by Bohn are used in the construction of skyscrapers throughout America.

BOHN ALUMINUM & BRASS CORPORATION
GENERAL OFFICES—LAFAYETTE BUILDING • DETROIT 26, MICH.
Designers and Fabricators
ALUMINUM • MAGNESIUM • BRASS • AIRCRAFT-TYPE BEARINGS

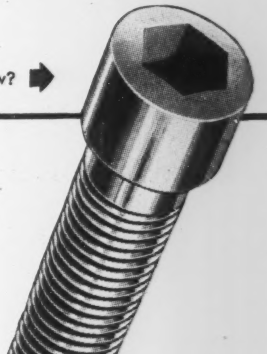


A. Is this a perfect circle?

Look Again!

DO YOUR EYES DECEIVE YOU?

B. What size is this socket screw?



● "Eye-gauging" shapes or sizes quickly and accurately isn't reliable, even for experts. Many a shop veteran failed in a recent test that required judging the size and pitch of an ordinary socket screw. It proved that "miking" is the only sure way to avoid errors . . . but that takes *time.*

The SIZE-MARK on the head of every P-K Socket Head Cap Screw ends gauging or guessing. It's an "exclusive" P-K feature . . . developed after an extensive study of shop practice.

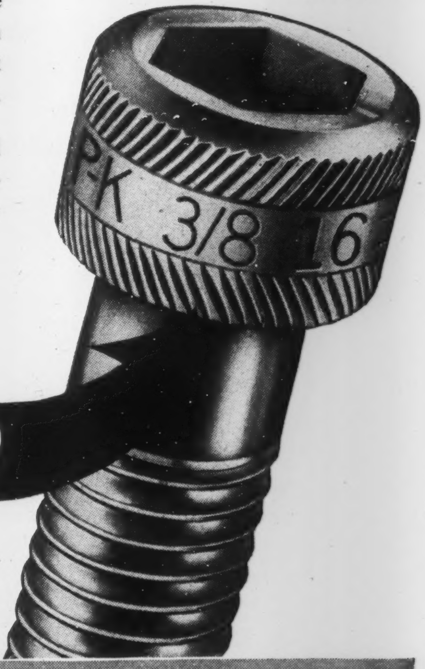
Tool crib bosses like the SIZE-MARK because it speeds up sorting of left-over, mixed-up screws . . . eliminates waste. Assembly workers like it because it speeds the job. Apprentices like it because it helps them learn faster—work faster. And sales managers recognize its advantages to customers' service men in the field on reassembly jobs.

PLUS . . . GEAR GRIP*

Makes fingers fly faster . . . because it prevents them from slipping even when oily. Only P-K offers Socket Head Cap Screws with both features.

SAMPLE KIT FREE. Compare and judge for yourself. Write Parker-Kalon Corp., 200 Varick Street, New York 14, N. Y.

Answers:
A. It is a perfect circle.
B. No question if it's Size-Marked!



You're sure at a glance

IF IT'S P-K... IT'S SIZE-MARKED

P-K SOCKET SCREWS ARE AVAILABLE FOR PROMPT DELIVERIES. SEND FOR STOCK LIST NOW.

*U.S. Pat. No. 126,409

SOLD ONLY THROUGH ACCREDITED DISTRIBUTORS

PARKER-KALON *Cold-forged* SOCKET SCREWS

Another P-K First—*GROUND THREAD* Socket Set Screws

● Smooth, mirror-bright, clean-finished threads—centerless ground on hardened blanks. Accurate contour and lead, dependable Class 3 Fit. Free from imperfections common to ordinary cut thread set screws . . . a "shining example" of good workmanship. Ask for samples. You'll see the difference.

18-8 stainless plus

HERE at Lebanon we often put plus factors into 18-8 castings which give added and very desirable characteristics to these justly famous stainless alloys. For example, in Circle Ⓛ 21* the addition of columbium in a fixed ratio to the carbon content of the alloy is recommended by us when the casting is to be part of a welded assembly. Acting as a carbon stabilizer, it protects a carbide breakdown at the weld which would jeopardize the corrosion resistant qualities of the alloy at that point.

That's why Lebanon's Circle Ⓛ 18-8s are not just Stainless but Stainless PLUS.

Write for new Data sheet giving chemical analysis and physical properties of all Circle Ⓛ Alloys.

LEBANON STEEL FOUNDRY • LEBANON, PA.

"In The Lebanon Valley"

ORIGINAL AMERICAN LICENSEE GEORGE FISCHER (SWISS CHAMOTTE) METHOD

*LEBANON CIRCLE Ⓛ 21

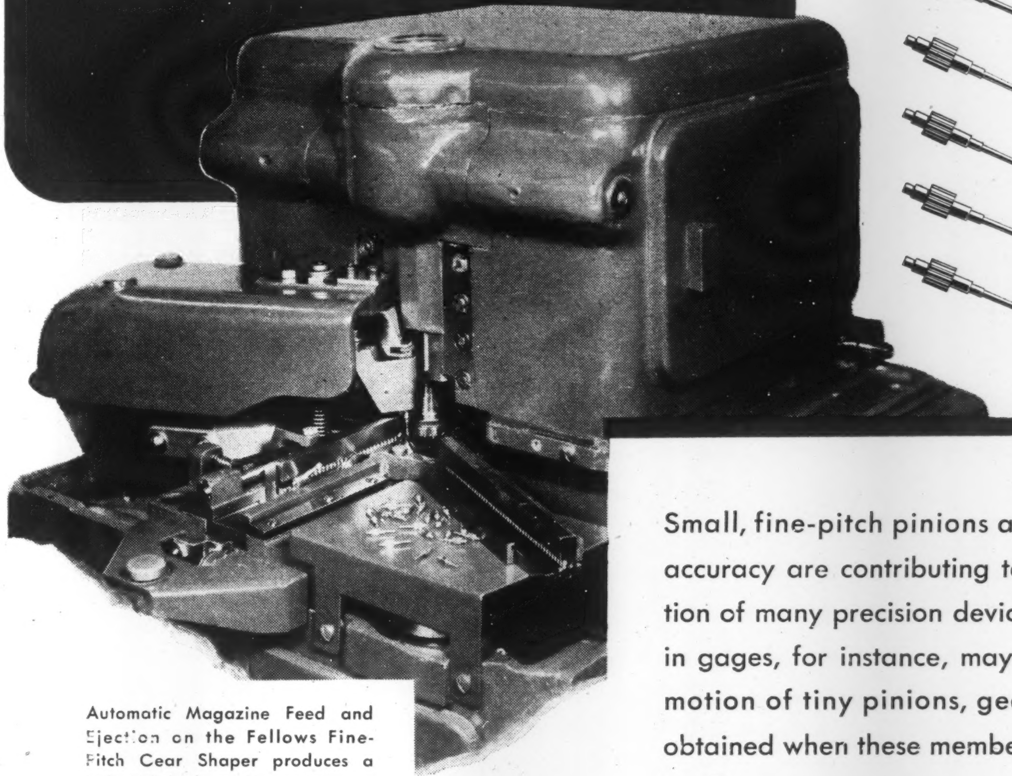
NOMINAL ANALYSES	
Carbon Max.	0.07
Silicon	1.25
Manganese	0.75
Chromium	19.50
Nickel	10.50
Columbium	0.80

NOMINAL PHYSICAL PROPERTIES	
Tensile Strength	80,000
Yield Point	41,000
Elongation in 2''—%	45
Brinell Hardness	145

Lebanon CIRCLE L ALLOY AND STEEL Castings

Wichita City Librar

INVOLUTE Teeth for Smooth Action



Automatic Magazine Feed and Ejection on the Fellows Fine-Pitch Gear Shaper produces a 113 pitch high accuracy pinion . . . 600 per hour!

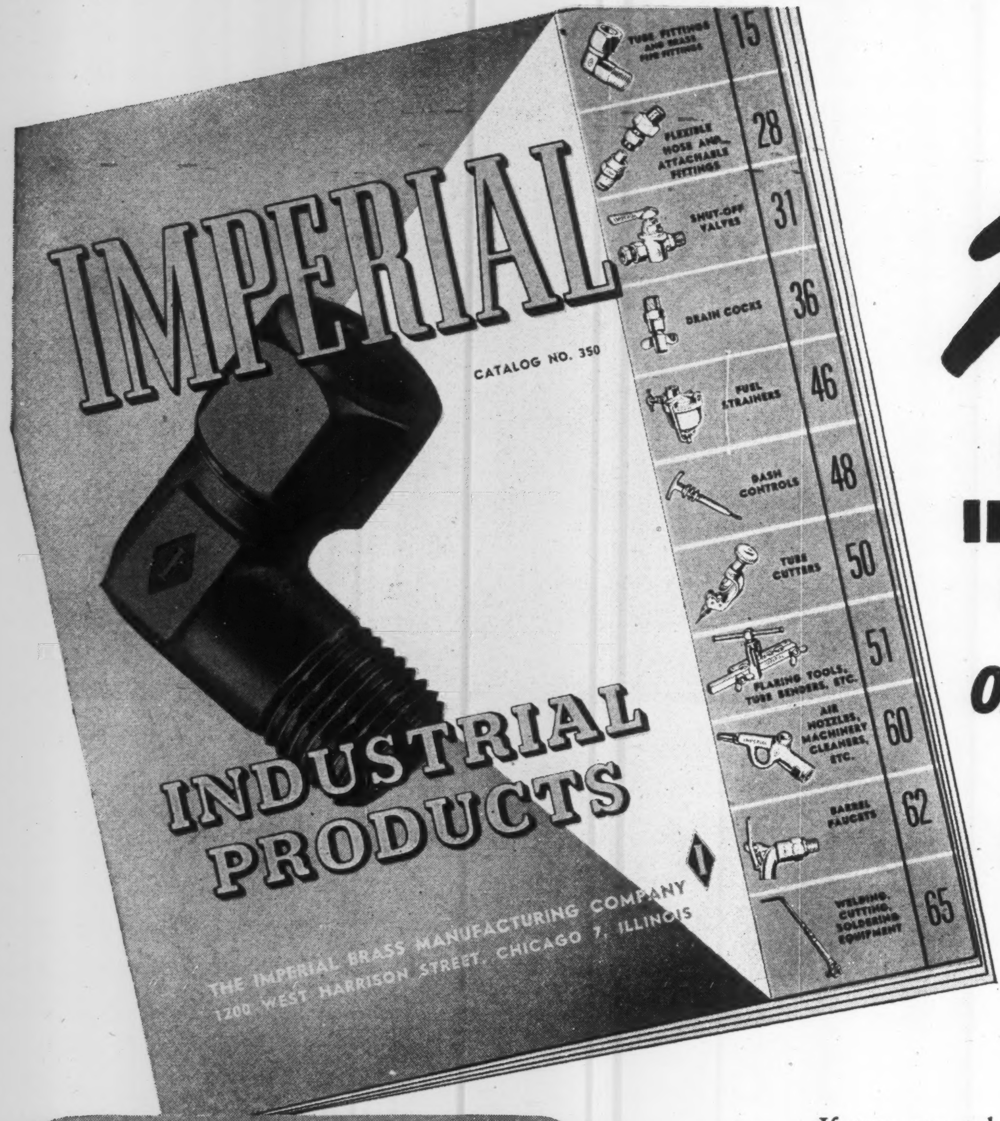
● Tiny Pinions and Gears Now Gear Shaper Produced with Pace-Setting Economy

Small, fine-pitch pinions and gears of high-involute accuracy are contributing to the quiet, smooth operation of many precision devices. Super-sensitive controls in gages, for instance, may depend upon the uniform motion of tiny pinions, gears, and segments . . . best obtained when these members have generated involute teeth.

The production of accurate fine-pitch gears, etc., is now at the designers' command . . . made possible on the Fine-Pitch Gear Shaper through super-speed cutter reciprocation, automatic magazine feed, and ganging of blanks on arbors. Designers will find much of interest in our illustrated book on Gear Shaper applications, "The Art of Generating with a Reciprocating Tool". The Fellows Gear Shaper Company, Head Office and Export Dept., Springfield, Vermont. Branch Offices: 616 Fisher Bldg., Detroit 2 . . . or 640 West Town Office Bldg., Chicago 12.

Fellows

THE FELLOWS METHOD...MACHINES AND TOOLS FOR ALL OPERATIONS FROM BLANK TO FINISHED GEAR


IMPERIAL
CATALOG NO. 350
INDUSTRIAL PRODUCTS
THE IMPERIAL BRASS MANUFACTURING COMPANY
1200 WEST HARRISON STREET, CHICAGO 7, ILLINOIS
TUBE FITTINGS AND BRASS PIPE FITTINGS 15
FLEXIBLE HOSE AND ATTACHABLE FITTINGS 28
SHUT-OFF VALVES 31
DRAIN COCKS 36
FUEL STRAINERS 46
DASH CONTROLS 48
TUBE CUTTERS 50
FLARING TOOLS, TUBE BENDERS, ETC. 51
AIR NOZZLES, MACHINERY CLEANERS, ETC. 60
BARREL FAUCETS 62
WELDING, CUTTING, SOLDERING EQUIPMENT 65

New

IMPERIAL INDUSTRIAL CATALOG

On Tube Fittings, Valves, Tube Working Tools, Equipment

If you use tube fittings, shut-off valves, tubing tools, fuel strainers or any of the many equipment items shown above, you will want a copy of this new Imperial Catalog No. 350.

It lists over 1100 sizes, types and styles of tube fittings for connecting copper, steel, aluminum and other thin-wall metal tubing from 1/8″ to 7/8″ O.D. A handy fitting selector chart describes the method of assembly, applications and advantages of the most popular types. Another illustrated chart tells you how to recognize the various types of fittings. Write for your copy today.

Now... Finer because they're FORGED

Imperial *leads again* with new, finer tube fittings for connecting copper, aluminum and other similar tubing . . . these new Imperial Fittings have forged bodies on elbows and tees and Dryseal Pipe Threads on pipe connections.

The superiority of forged brass fittings has long been recognized because:

FORGED FITTINGS ARE STRONGER
FORGED FITTINGS ARE TOUGHER
FORGED FITTINGS ARE CLOSER GRAINED
FORGED FITTINGS ARE MORE UNIFORM

Fully described in Catalog 350.

THE IMPERIAL BRASS MFG. COMPANY
513 S. Racine Ave., Chicago 7, Ill.

IMPERIAL

PIONEERS IN TUBE FITTINGS AND TUBE WORKING TOOLS

The Vital Element in the IMPROVEMENT of Metals by Forging ...is MEN!

Symbol of a Forging Service,

the use of which never has to be defended

This Diamond-S symbol on a forging identifies metal quality developed fully to meet a specific service condition. Minimum scrap loss and reductions in the cost of machining and processing are other advantages usually associated with this symbol. Unvarying quality, as well as the cost of a forging, is determined by its design, the material of which it is made, and the forging techniques required to form it.

Fortified by over 34 years of experience in forging intricate designs, and by specialized metallurgical and engineering skill thus acquired, Steel Improvement Forging Engineers and Metallurgists: (1) know the exact forging technique that should be utilized for developing fully the qualities, inherent in a specific grade of steel, that are required to meet the stresses occurring in a specific service condition; (2) advise and assist designers regarding the correct placement of parting lines and other design elements; and (3) adhere strictly to a policy of projecting a promise of quality and delivery only when such promise can be substantiated by fact or experience, or both. Consult a Steel Improvement Forging Engineer about the measure of quality in forgings you require.

THE STEEL IMPROVEMENT & FORGE CO.

SALES OFFICES: NEW YORK • CHICAGO • TULSA
INDIANAPOLIS • MILWAUKEE • LOS ANGELES

954 East 64th Street • CLEVELAND, OHIO

DROP, UPSET AND PRESS FORGINGS FROM A FEW OUNCES TO 500 LBS. OF CARBON AND ALLOY STEELS

Topics

CAST-MAGNESIUM aircraft wings in which the skin and reinforcing members are cast integrally are in the advanced stage of development and are expected to be tested on high-speed craft.

PLASTIC PILLOWS of extruded polystyrene when used as a protective blanket over chromium plating tanks have proved effective against loss of acid in the form of spray, dissipation of heat and escaping fumes. Developed by Udylite Corp. in conjunction with Dow Chemical Co., these short plastic tubes float on the bath in sufficient depth to lessen the escape of fine spray yet are easily displaced when a rack of objects is lowered into the solution.

FOR EMPLOYEE EDUCATION the General Electric Co. has announced a $1,000,000 program for 1947. More than 12,000 employees and 500 instructors participate in courses ranging from apprentice training to scientific subjects.

TO MAINTAIN STEELMAKING operations at high levels, additional quantities of ore, replacing up to 13 per cent of scrap, are being charged into the furnace. Shortages in and deterioration of the quality of scrap have been responsible for the development of this new technique which requires the use of high-grade lump ore.

HELICOPTERS have been used successfully for spraying orchards. Upwash from the rotor effectively deposits the chemicals on the underside of leaves and fruit as well as the topside. Also, helicopters have saved ripened fruit from rot by flying low over orchards, drying the fruit quickly by means of the upwash.

SEAMLESS PIPE and tubing will be produced with lighter walls and within closer dimensional tolerances than is possible on conventional or automatic seamless mills. For the new process the National Tube Co. is building a mill at Lorain, Ohio, which will double speed of production without changing roll surface speed or feed angle. An internal mandrel extends entirely through the pierced billet and passes through the mill with the work piece. A rounding up operation facilitates withdrawal of the mandrel.

TIME-TABLE of known national reserves of resources based on peacetime usage (1935-1939) is: Chromium 1 year, manganese 2 years, mercury 3 years, tungsten and antimony 4 years, vanadium 7 years, silver 11 years, lead 12 years, petroleum 18 years, zinc 19 years, copper 34 years, and iron ore 111 years.

FORMULA for matching thermal coefficients of expansion of the components in plastic and metal-bonded materials as well as other sandwich materials has been developed by P. S. Turner at the National Bureau of Standards. Use of the formula has shown that coefficients can be matched to give a bond resistant to temperature changes.

A SYSTEM for air transport is needed to coordinate into a minimum number of units all of the functions of air navigation, to present adequate information to the crew in a manner far simpler and more natural than present day methods, and to take full cognizance of human limitations. Indicative of the complications and burden placed upon the crew is the fact that there are some 434 instruments and knobs in the cockpit of a DC-4.

CANNED FOODS now include sauce or other food product, the flavor of which is not desired to mix with the contents of the can until serving, packed in a pliofilm bag within the can.

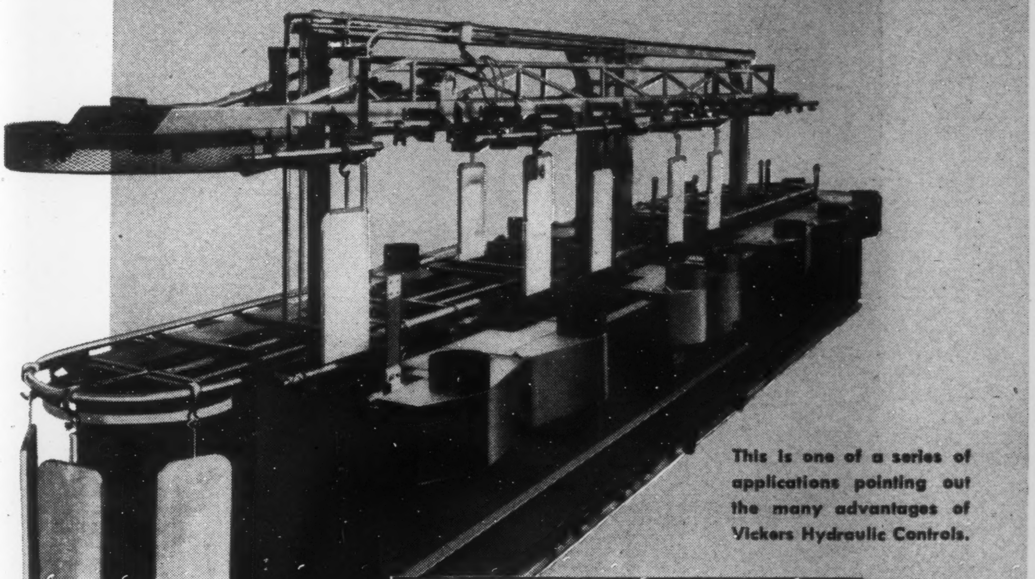
HEATING AIRPLANE ANTENNAS with alternating current of 200 to 1000 cycles prevents icing without interfering with radio communications. Unit consists essentially of a transformer and condenser, the antenna itself acting as the heat conductor.

VICKERS HYDRAULIC EQUIPMENT

helps achieve

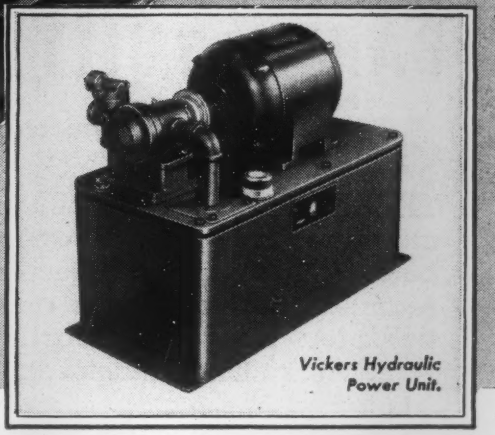
HIGH PRODUCTION
SPACE ECONOMY
UNIFORM QUALITY

IN Udylite AUTOMATIC PLATING MACHINE



This is one of a series of applications pointing out the many advantages of Vickers Hydraulic Controls.

Above: Elevated position for transfer from one tank to the next.



Vickers Hydraulic Power Unit.

This Udylite machine does a complete plating job automatically . . . taking each part through seven tanks and a drying chamber . . . timing exactly the interval in the various solutions for cleaning, plating and rinsing.

Each part (or rack of parts) is automatically lowered into each of the seven tanks in turn—then lifted out and transferred to the next tank. This might be done with a multiple dip conveyor. But the conveyor slants permissible in lowering and raising in that way require extra tank length.

Udylite made the machine far more compact—saving 18″ to 24″ in the length of each tank—by using Vickers Hydraulic Equipment to raise and lower the entire conveyor assembly at each transfer. By this means, each piece (or rack) is lifted straight out of the tank, moved over the next tank and lowered straight down. This provides better cleaning and more uniform plating—better drainage and less contamination of the solutions.

The Vickers Hydraulic Power Unit and Control Valves have many advantages for such applications: (1) proven dependability, (2) accurate control and precise timing, (3) flexibility of control to suit varied production requirements, etc.

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New BULLETIN

Write for Bulletin 46-43 describing Vickers Hydraulic Power Units.

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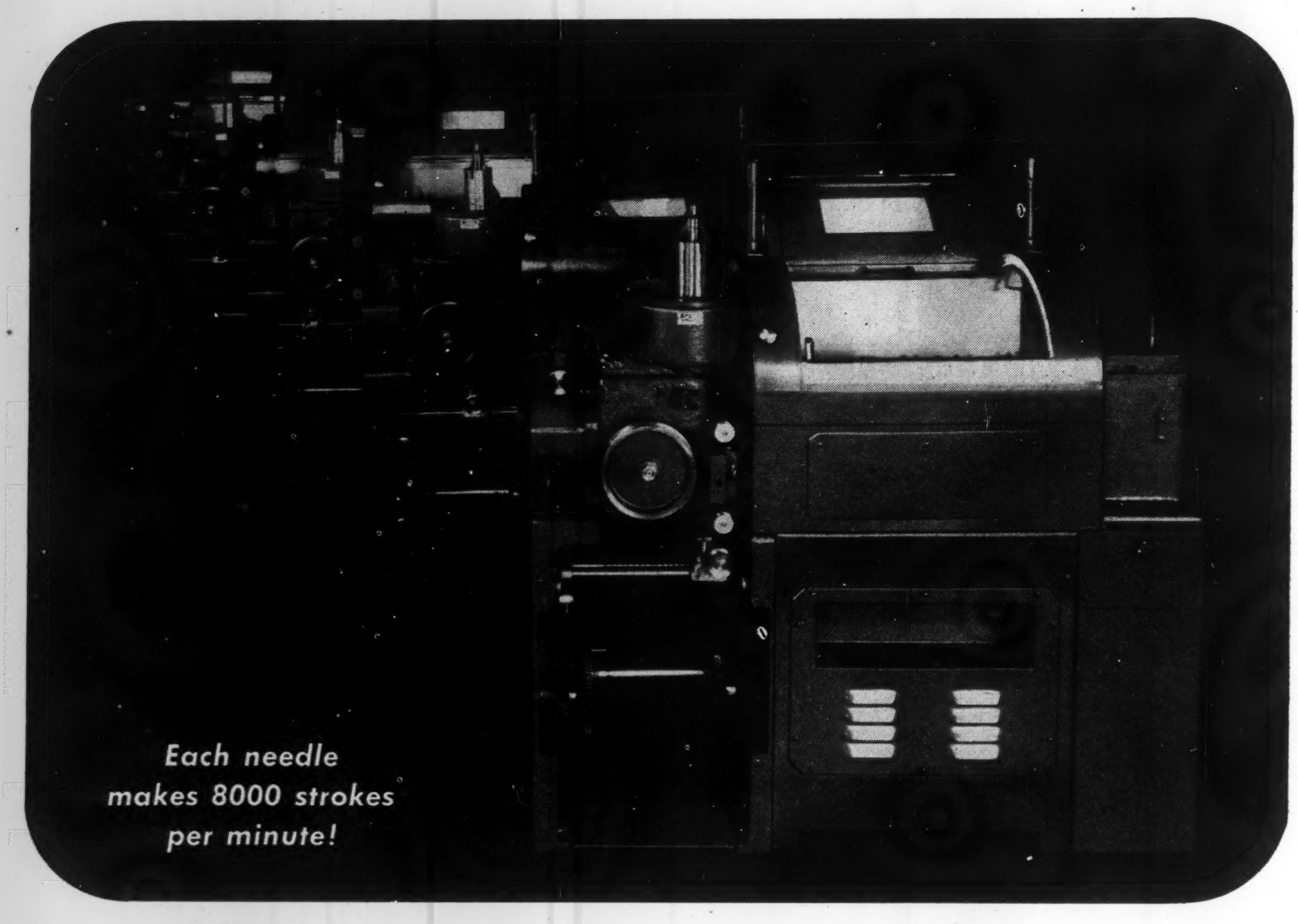

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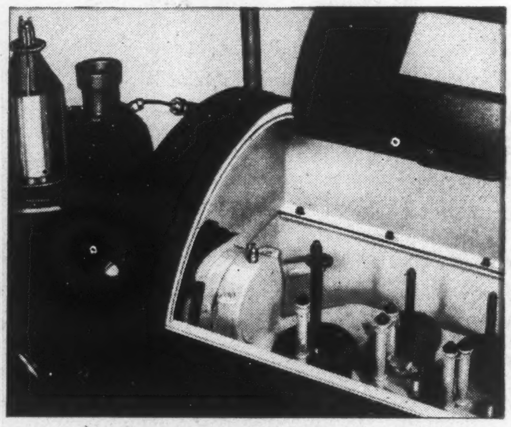

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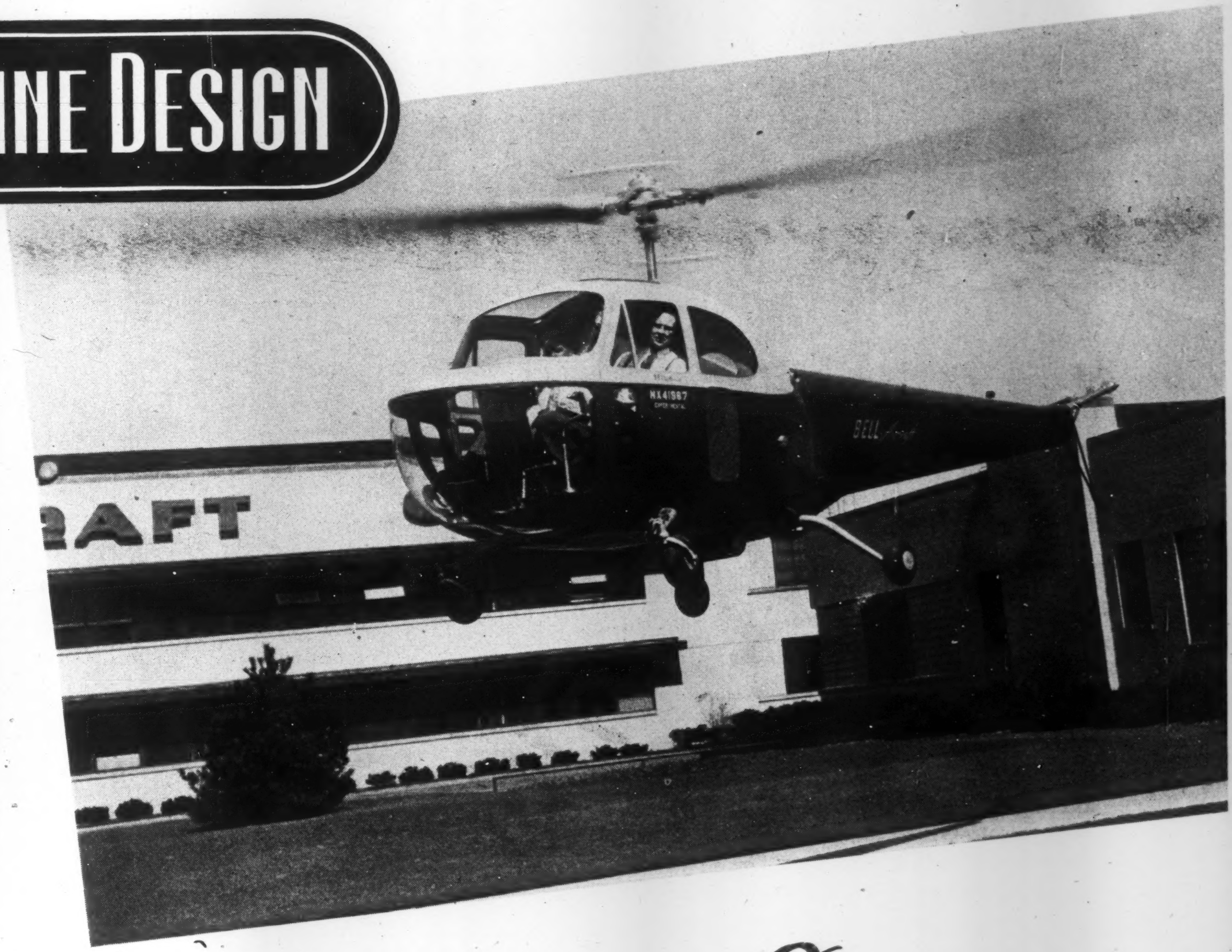


Helicopter Control Systems

New design prevents pendulum-like swinging of the inherently unstable helicopter

By George D. Ray

Special Projects Engineer
Bell Aircraft Corp.
Buffalo

HELICOPTER design largely centers around control systems which will provide stable, easily-directed flight. Early helicopters with their poorly-contrived controls were unable to hover in air and on becoming airborne invariably began a back-and-forth swinging motion. Thus, little progress was made in development until the major problem was identified as inherent instability. With this step taken, however, helicopters are being produced on an assembly-line basis and adapted for use by commercial, military, agricultural and government bodies.

The Bell two-place Model 47 helicopter, being a small

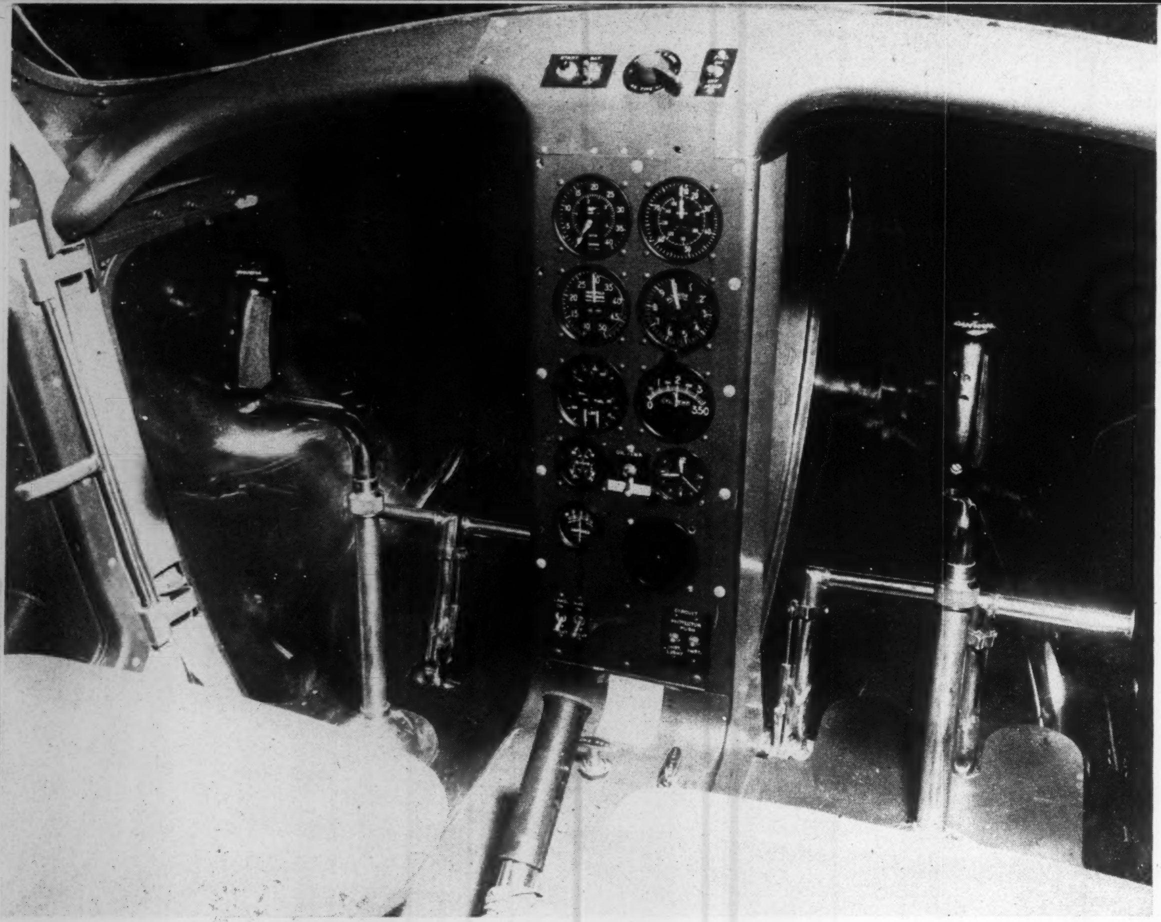


Fig. 1—Dual controls in helicopter cabin. Cyclic-pitch sticks are seen in vertical position in front of seats, while collective-pitch sticks are seen to left of each seat

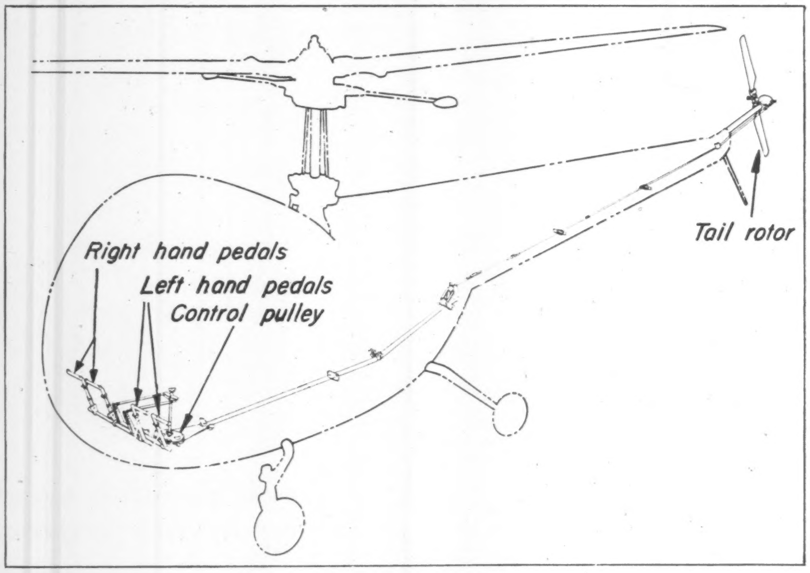


Fig. 2 — Tail-rotor control assembly. Motion of foot pedals is transmitted by pushrods and cables to jack screw in tail housing. Screw then changes rotor blade angle

aircraft, is particularly well suited to serve as an illustration of the application of flight controls and stability factors. This machine employs the rotor configuration originated by Arthur M. Young, consisting of a single two-bladed rigid rotor, a flexibly-mounted engine and mast, and a stabilizing bar to improve the dynamic stability. Torque reaction of the main rotor is balanced by a small tail rotor in the conventional manner.

Control Procedure: The pilot of a helicopter, like the fixed-wing aircraft pilot, has rudder pedals and a vertical stick universally mounted at the level of the cockpit floor, *Fig.* 1. However, unlike the conventional aircraft pilot he has at his left side a second, horizontal stick control, pivoted on an athwartship cross shaft located just below and approximately at the rear of the pilot's seat. Movement of the rudder pedals adjusts the pitch of the tail rotor blades, thus balancing the main rotor torque to align the fuselage in a fore and aft direction when in forward, aft or sidewise flight, or rotating the fuselage to change the direction of the machine. Movement of the forward end of the horizontal stick (called the collective pitch stick), in an upward direction increases the pitch of both main rotor blades equally to increase or decrease altitude. Movement of the vertical stick (called the cyclic-pitch stick) in a forward direction produces forward flight, while neutral stick produces hovering flight and aft movement produces rearward flight. This is in contrast to the action of the stick of a conventional airplane which regulates primarily the airplane's angle of attack and secondarily the airplane's flight-path angle. Similarly, sidewise motion of the cyclic pitch stick produces sidewise flight rather than an angle of bank.

Control Elements: The tail rotor control system, *Fig.* 2, consists of linkages, drums, control cables and a jack screw. Motion of the rudder pedal is transmitted by push-pull rods to a drum, thence by control cable to a second drum which rotates a jack screw. This in turn moves a pair of links to rotate the tail rotor blades on their feathering axis changing rotor thrust. Loads in this control system are very light. Operation of the rudder pedals is the same as in fixed-wing aircraft, movement of the left pedal resulting in change of direction to the left,

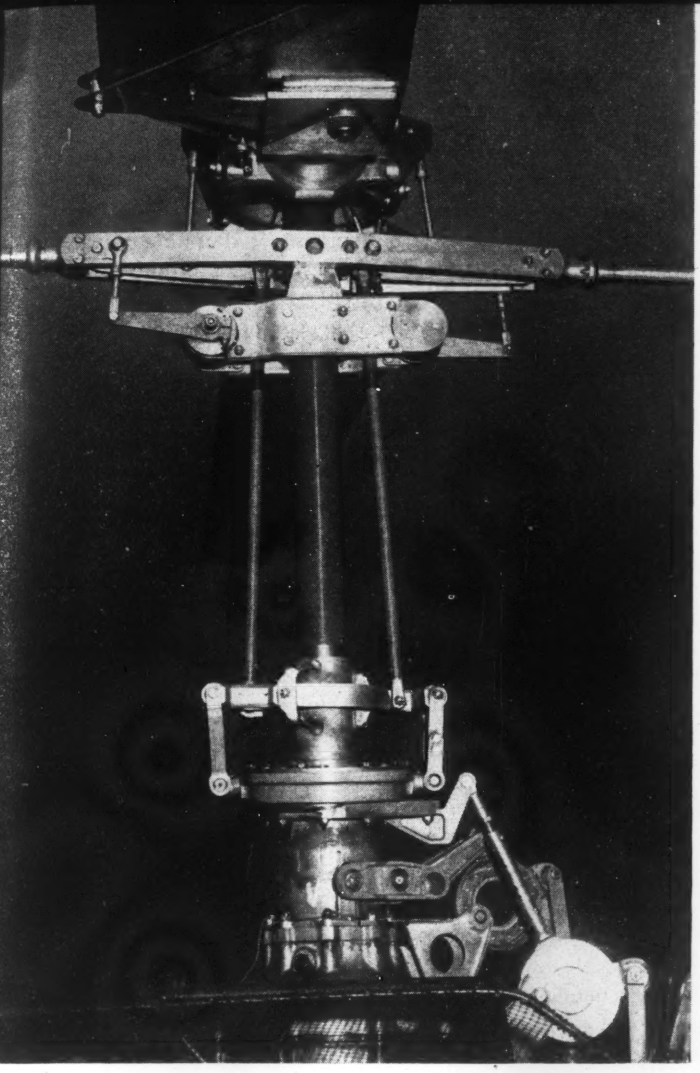


Fig. 3—Helicopter mast. Stabilizing bar below rotor provides balance. Large assembly below bar is swashplate

and of the right pedal, a direction change to the right.

Upon the mast, *Fig.* 3, are mounted a linkage known as the swashplate, a stabilizing bar and the main rotor, in that order upward from the engine. The swashplate, encircling the mast close to its base, is mounted on a gimbal-ring type support so that it may tilt in any direction. Movement of the cyclic-pitch stick results in tilting the swashplate, *Fig.* 4. Here, deflections transmitted through the cyclic-pitch linkages are imposed on the rotating control parts through ball-bearing supported elements. Thus, the blade angles of the rotor blades are changed in opposite direction (i.e. increased and decreased in equal and opposite direction). This is shown in *Fig.* 5. It will be seen that for a given cyclic-pitch position the blade angles will vary cyclically, going through one complete cycle per revolution. Movement of the collective pitch lever, *Fig.* 6, causes a vertical motion of a sleeve within the swashplate support, thus increasing or decreasing the blade angles equally. The collective pitch control is combined with the cyclic control through a mixing lever arrangement at sleeve top.

Stabilizing System

The stabilizer bar consists of two weights at the ends of a rod and bar assembly pivoted on the mast just below the rotor. A mixing lever arrangement causes equal and opposite changes of the rotor blade angles when the bar is tilted and the cockpit controls are restrained. It will be obvious that if the mast is suddenly tilted, the rotating bar and weight assembly will tend to remain in its original plane of rotation, thus changing the blade angles in a cyclic manner. The result of this correction is to offset

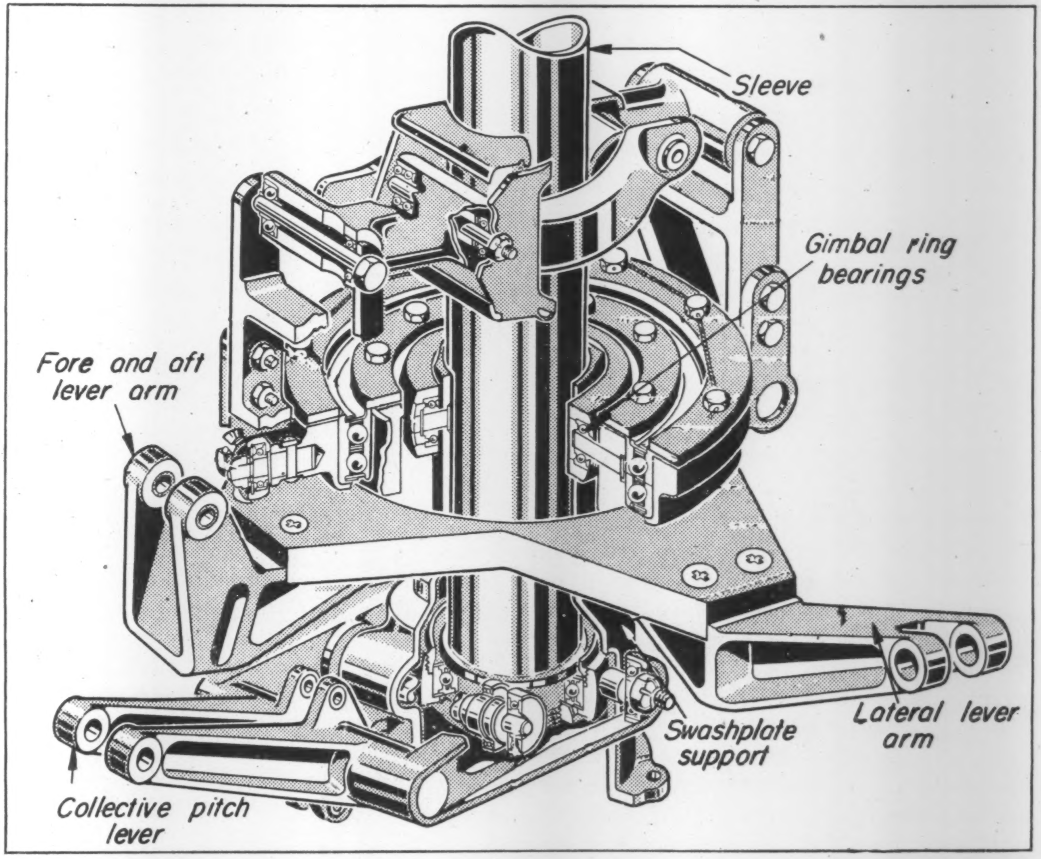


Fig. 4—Detail of swashplate. Collective-pitch lever raises sleeve, transmitting uniform deflection to rotor blades. Cyclic-pitch (fore and aft and lateral) levers tilt swashplate, transmitting cyclic deflection to blade through ball-bearing ring

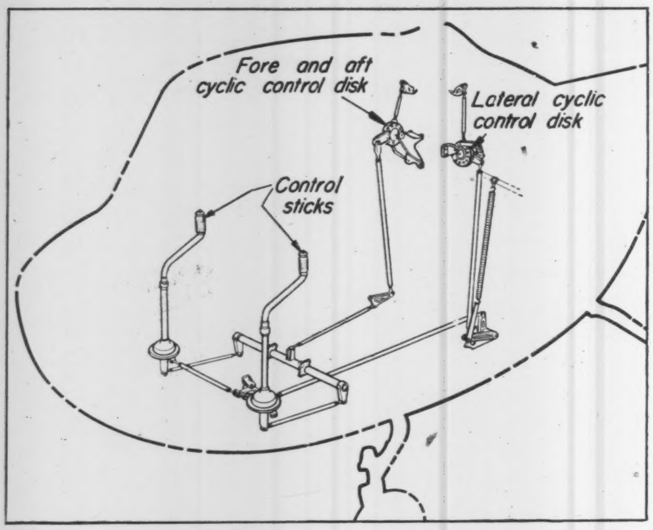
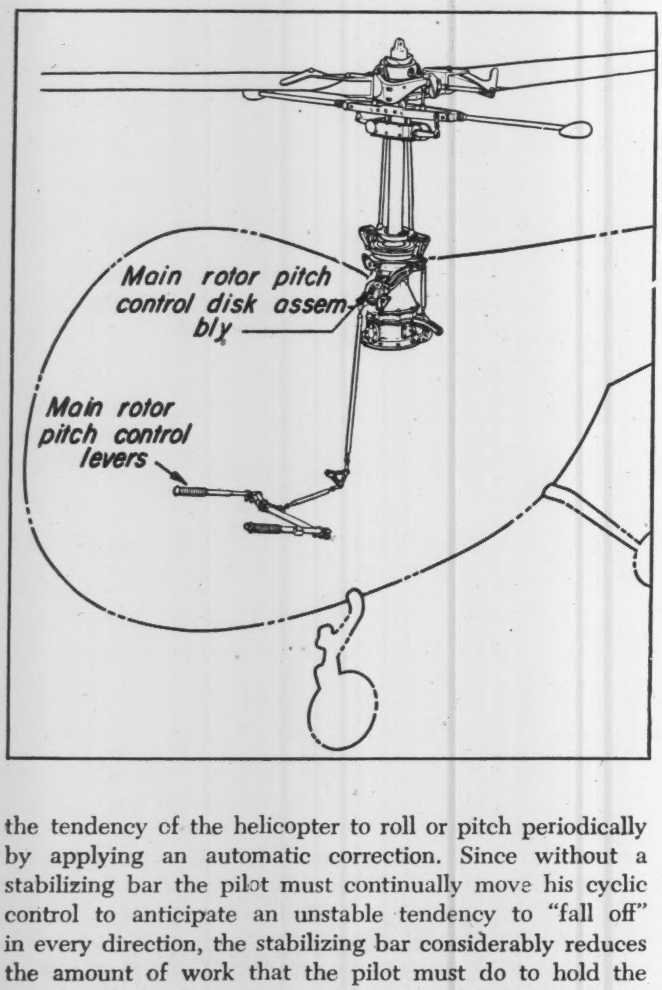


Fig. 5—Above—Cyclic-pitch control sticks are linked to swashplate through fore-and-aft and lateral control disks

Fig. 6—Below—Collective-pitch control stick varies rotor-blade pitch through main rotor pitch control disk which raises and lowers sleeve of Fig. 4


Main rotor pitch control disk assembly
Main rotor pitch control levers

the tendency of the helicopter to roll or pitch periodically by applying an automatic correction. Since without a stabilizing bar the pilot must continually move his cyclic control to anticipate an unstable tendency to "fall off" in every direction, the stabilizing bar considerably reduces the amount of work that the pilot must do to hold the machine level. This is especially true of hovering flight.

While excellent stability is achieved by this arrangement, it is necessary to force the bar to follow the mast by attaching it to the mast through automotive-type hydraulic dampers. These serve to prevent wild oscillations of the bar, since the bar's natural frequency in see-saw motion is equal to the speed of rotation of the mast; and to improve maneuverability since, as in fixed-wing aircraft, excessive stability results in the necessity for excessive control to perform a given maneuver. Thus, by adjusting the damper rate of increase of damping movement with angular travel, the desired compromise between stability and maneuverability can be obtained.

The main rotor consists of two assemblies, the blades and the hub. Each of the two blades is attached rigidly to the hub, *Fig.* 7, having no flapping or lagging hinge. Journal bearings are provided between the hub and each blade to provide collective blade-angle change (simultaneous increase or decrease of blade incidence). The blade and hub assembly is attached to the mast by means of a Cardan-type universal joint, permitting both "see-saw" and feathering motion of the blade. This permits cyclic-pitch to be controlled by rocking the hub about the feathering or spanwise axis.

Hub assembly is composed of two main assemblies, a gimbal ring and a yoke. The gimbal ring (upper section of the assembly) provides universal action for the azimuth position of the blades while the trunnion of the ring provides the mounting point of the hub assembly to the rotor mast. The yoke (lower section of the assembly, to which the blade grips are mounted) is secured to the gimbal ring in such a manner as to permit the hub assembly to pivot or see-saw. Pitch equalization is provided by interconnecting linkage between the horns on the blade grips. The linkage consists of an equalizer beam mounted on each side of the yoke, and adjustable link rods which connect between the ends of the beam and the horns on each blade grip. As a result of this connection, when blade angles are being changed the angle of both blades is changed simultaneously and equally. A static stop is mounted on the mast, under the rotor-retaining nut. This prevents excessive see-saw movement of the hub. Dynamic stops are cable assemblies connected between the gimbal ring and the stabilizer bar to prevent excessive see-saw or flapping action during maneuvering flight.

Feed Back Elimination

Irreversible Controls: Mounted below the swashplate assembly and attached to the transmission are the control disk assemblies, *Fig.* 8. Three are used, one for fore and aft cyclic control, one for sidewise cyclic control, and the third for collective pitch control. The disk assembly consists of two chamfered, bronze disks and a steel ring which fits into the V formed when the disks are assembled. A push-pull tube attached to a fitting on the steel ring connects the disk assembly to a horn on the swashplate. The bronze disks are pivoted eccentrically on a bolt running through a support on the transmission case. Diametrically opposite the pivot point, a push-pull tube leading to the cockpit control is attached to the disks. The purpose of the disk assembly is to permit the pilot to move the controls, but prevent forces from the rotor from feeding back. As in the case of road shocks in an automobile steering gear, the rotor forces are not entirely prevented from feeding back, but are greatly reduced.

Various other types of irreversible control have been either used or proposed. These can be classified as friction locking, and intermittent locking. The former are such mechanisms as the disk, screw-jack, and cam types of irreversible units. While these differ in detail and in ease of construction and installation, they are similar in operating characteristics. To be irreversible, they must have an efficiency of 50 per cent. That is, the pilot must push twice as hard to change the rotor blade angles as he would if no irreversible was used. The intermittent-locking irreversible has often been proposed, but is difficult to use in a control system because it depends upon an appreciable backlash to operate it. It may be difficult to unlock when a load is being applied from the rotor side of the irreversible control system, especially if it uses a "free wheeling" type of locking device. If the load from the rotor side of the control system is in the direction that the pilot is trying to move the control, a severe chatter is likely with this type of control.

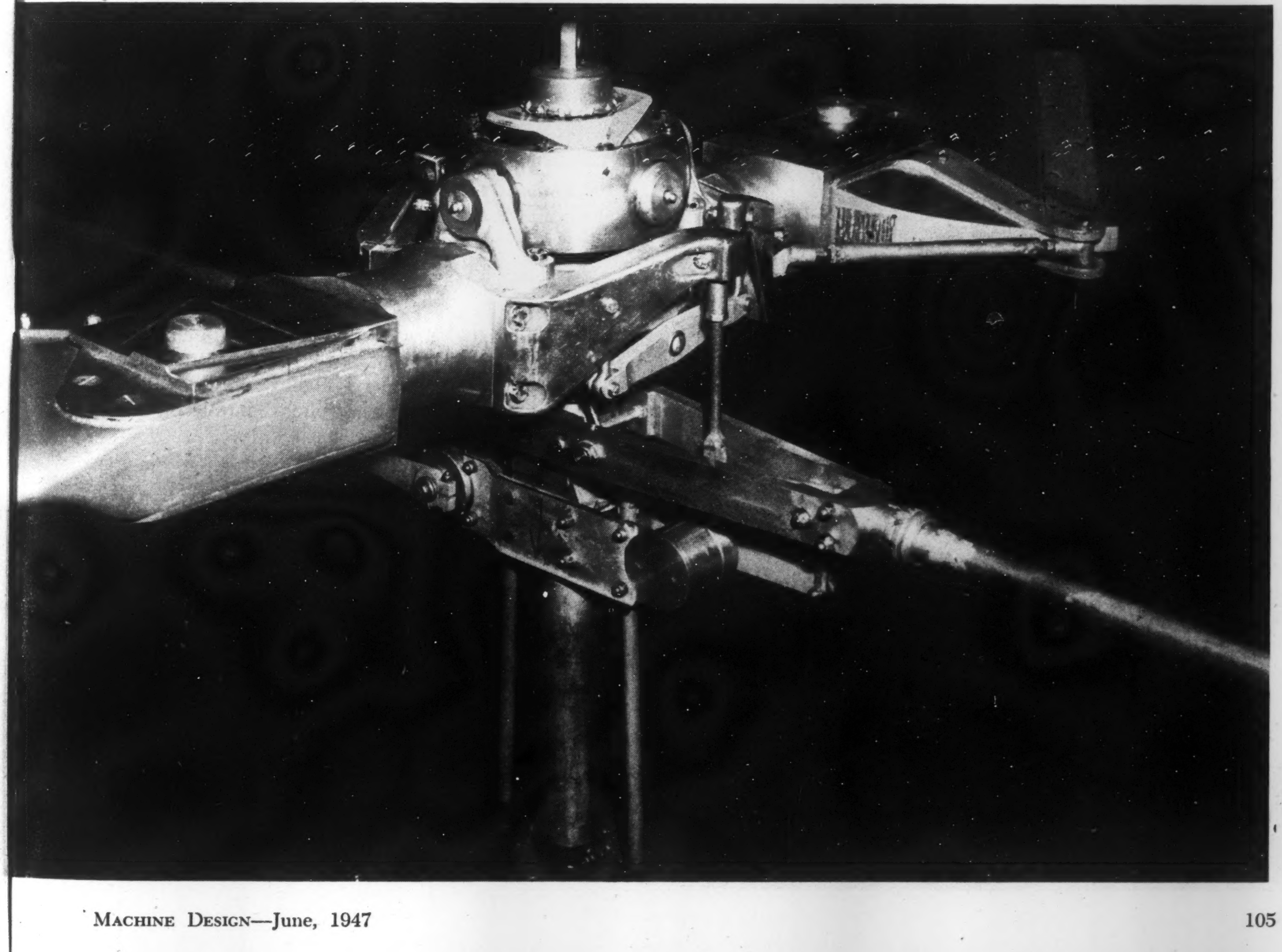
It is possible to design a hydraulic lock which is similar to a boost control except that, instead of using an additional supply of power to operate the controls, the ends of the actuating cylinder are connected when the pilot wishes to change the blade angles. In this case the valve design must be carefully selected to avoid the type of chatter mentioned. The chief reason for wishing to use the intermittent locking type of irreversible is, of course, to obtain a 100 per cent efficient unit. It should be noted that because of the difference between static and sliding friction, chatter can also be obtained with the friction-type irreversible mentioned, especially if a poor lubricant or none is used on the sliding surfaces.

When designing friction types of irreversible units, caution should be used with regard to calculating the "lead" required for irreversibility. Instead of being a true constant for two surface materials in contact, the coefficient will vary to some extent with the contact pressure. Thus, reducing the lead of a screw jack may make it easier rather than harder to operate if more contact area is provided, even though the mechanical advantage between the pilot's control and the hub is kept the same.

Throttle Control: The pilot's throttle control is a rotating grip mounted motorcycle fashion at the end of the collective pitch control stick as seen in *Fig.* 1. This is connected to the throttle butterfly valve through linkages and a Shakespeare flexible control. During maneuvers the helicopter pilot must coordinate his throttle closely to provide sufficient engine torque to maintain a constant rotor speed. In the case of the Bell Model 47 helicopter it is desirable to keep the engine rpm between 2900 and 2000 during flight. Because this close coordination requires a great deal of attention from the pilot, two chief types of mechanisms are used to provide automatic changes of throttle position as the required torque varies during maneuvers.

The simplest of these mechanisms is a linkage connecting the throttle grip to the throttle butterfly. This contains a mixing lever which is actuated both by the throt-

Fig. 7—Tilting of stabilizing bar, through helicopter tilting, results in compensating change in rotor-blade pitch



tle grip and by a connection into the collective-pitch control system. By providing a differential motion in the linkages, the throttle can be opened approximately as required for an increase of pitch. However, the use of a throttle-pitch coordinating linkage prevents making practice autorotation landings with an idling engine, since when the collective-pitch lever is raised in flaring out, the linkage opens the throttle. Addition of a spring link and lock mechanism actuated by the pilot during the autorotation glide can be used to prevent throttle-pitch coordination when not wanted. The lock can be arranged to release if the pilot starts to open the throttle, so that power can be applied quickly if needed.

Another type of autorotation mechanism consists of a spring located in the throttle linkage adjacent to the throttle butterfly. By turning the throttle handle in the decrease direction beyond the throttle-closed position the spring link is extended. Raising the pitch lever releases the spring but does not open the throttle until the linkage moves the length of the spring travel. While this mechanism requires a larger motion of the throttle grip if power is needed quickly, it does not require a separate cockpit control.

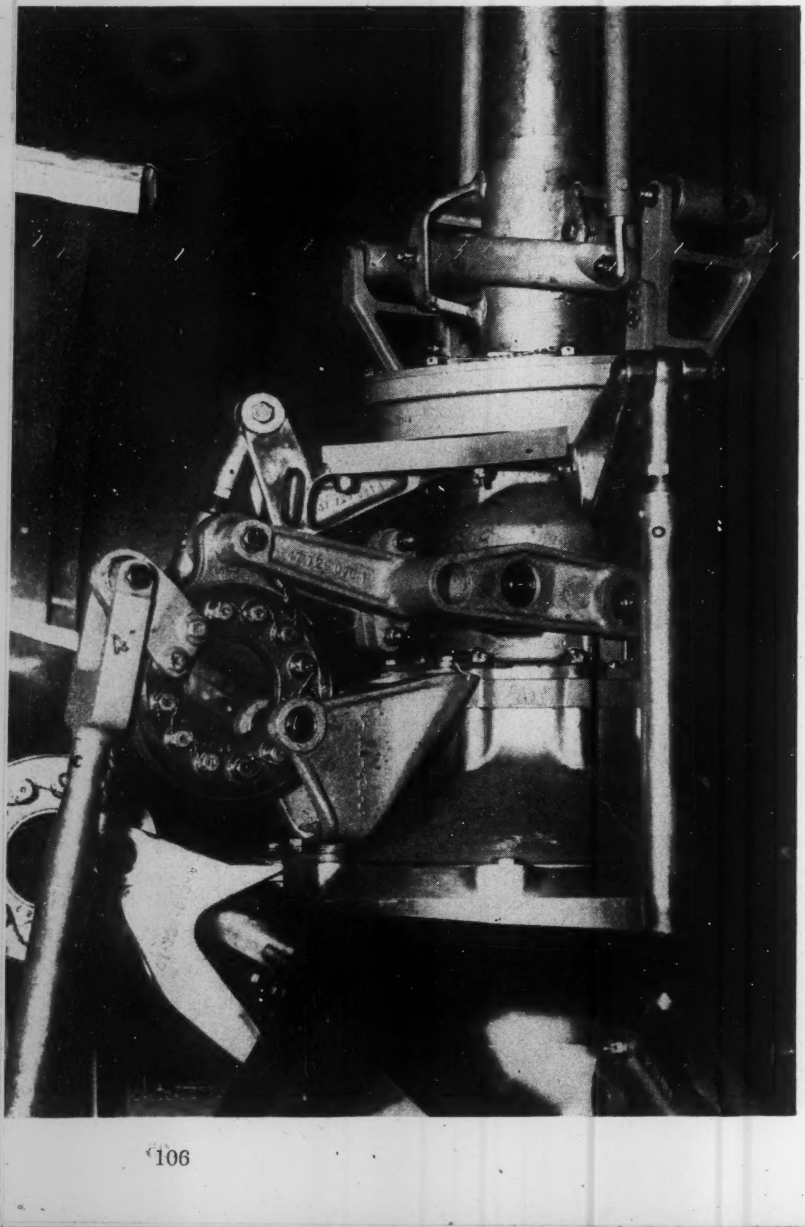


Fig. 8—Below—Closeup showing control disks and swashplate assembly. Disk in foreground is for collective pitch. Beyond and below is fore-and-aft cyclic control disk. Lateral cyclic control disk is at lower end of vertical rod at right. It is linked to lateral lever arm shown in Fig. 4

Since a helicopter rotor is similar to a controllable-pitch propeller, a servomechanism to change the main rotor collective pitch setting in such a way as to keep the rpm constant for a given throttle setting is an obvious means for reducing the work of piloting a helicopter, just as the constant-speed propeller control is used to reduce the work of flying a fixed-wing aircraft. However, it should not be forgotten that whereas the propeller-pitch controls of an airplane are secondary power plant controls, as distinguished from the primary flight controls (ailerons, elevator and rudder), the rotor-pitch controls of a helicopter are the helicopter's primary flight controls. For this reason, it is generally conceded that a throttle governor, *Fig.* 9, rather than a pitch governor, is more logical in the case of the helicopter, since it leaves the function of operating the primary-pitch controls to the pilot, while turning control of the throttle over to a servomechanism. The ease of installation and light weight of a throttle governor are also considerable advantages for this type.

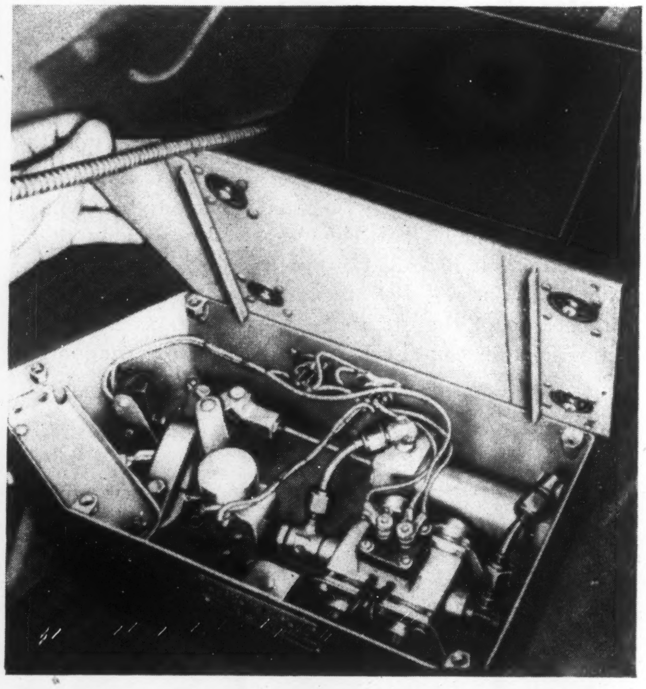


Fig. 9—Above—Throttle governor consists of two elements. Top box shown tilted contains sensing unit. Lower box, which is shown open, is actuating unit

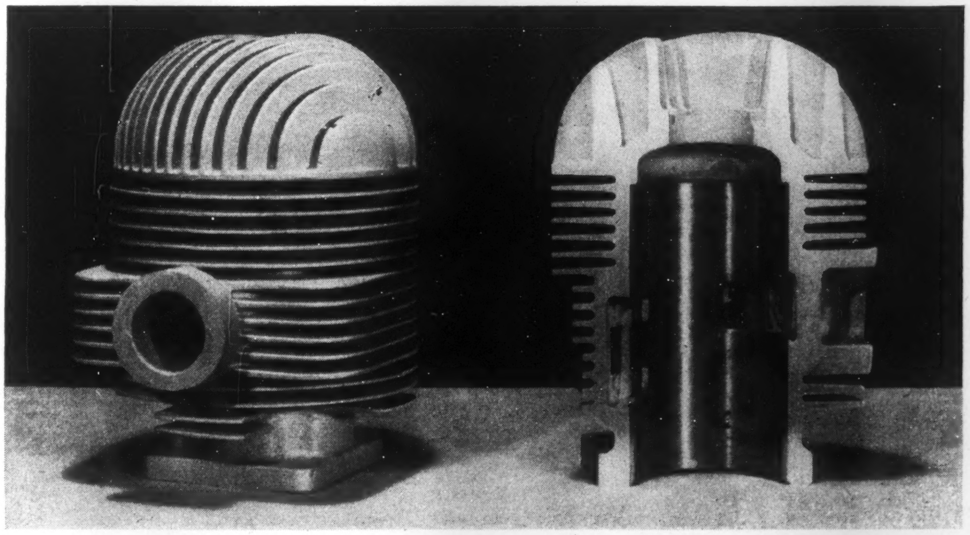
Against these advantages for the throttle governor should be balanced the points that a throttle governor cannot control rotor rpm during autorotation and will not give the pilot warning of carburetor icing. While it seems that constant-speed rotor controls for helicopters will eventually be used at least as widely as constant-speed propeller controls for conventional airplanes, such controls must yet undergo a considerable period of development before their merits can be said to outweigh their additional complication.

Scanning THE FIELD for Ideas

INCREASED efficiency of heat transfer is obtained from the cast-aluminum cylinder barrel illustrated below. This barrel, cast on a thin-wall steel cylinder liner, has no measurable loss across the ferro-aluminum bond between the liner and barrel. By way of comparison, thermal drop across a mechanical-contact joint between aluminum alloy and steel is about 2 per cent of heat dissipation. In addition the cast barrel is pure aluminum (2S) having about 35 per cent greater heat conductivity than alloys usually employed in shrunk-on systems.

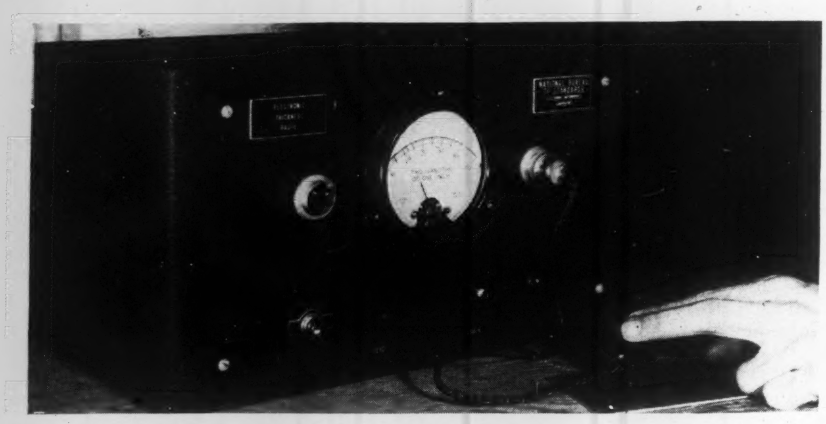
Bond produced by this method, developed by Al-Fin Corp., is permanent with no risk of developing a heat dam. Also, the process permits a somewhat lighter structure because the steel cylinder wall does not require the strengthening necessitated by other methods. Production costs are low since there is no accurate machining involved between the liner and barrel. The bond when produced with 99+ per cent pure aluminum and SAE 4140 steel has a tensile strength of approximately 6000 psi and a shear strength on the order of 7000 psi.

Fins may be cast on if the pitch is not greater than six to the inch and the depth is not too great, otherwise the fins themselves are machined. The process using either sand cores or permanent molds has also been successfully used for steel-backed aluminum bearings, aluminum gears with steel hubs, heat exchangers, and metallic pistons. Other aluminum alloys such as 43, 142, 195, 355, 356, C-113, etc., which have a much higher strength than pure aluminum, can be bonded successfully to cast iron, Ni-resist, carbon steel, alloy steel, etc. In some cases, the aluminum alloy can be aged after processing to obtain desired properties.



Electronic micrometer, shown at top of next page, utilizes the principle that the field surrounding a coil carrying alternating current will induce current in an adjacent coil and that the amount of induced current can be controlled by placing a shield at various distances from the latter coil. The device developed by M. L. Greenough of the National Bureau of Standards was designed to measure thickness of the oil film in the bearings of a large Navy turbine shaft.

Radio-frequency energy radiated from a coil is at zero at the surface of a perfectly conducting shield adjacent to that coil. This occurs because eddy currents are set up in the shield by the field of the radiating coil and these currents induce an opposing magnetic field at the surface of the shield. The opposing field exactly cancels the incident field at the surface of the metal plate. Theoretically, a pickup coil of zero thickness ap-



plied at the surface of the shield would receive no energy. Compensation, therefore, for the thickness of the coil has been included in the design.

When the pickup coil is moved away from the shield, the radiated field becomes stronger while the field setup by the currents of the shield become weaker. This condition becomes more marked as the distance increases. Because the metal background is not a perfect conductor and because the coil has thickness, a third coil is added to obtain a zero reading. Induced voltage is measured either on an oscilloscope or by an alternating-current meter. Readings to 0.0001-inch are easily obtainable and indications on a meter are linear within a fraction of one per cent.

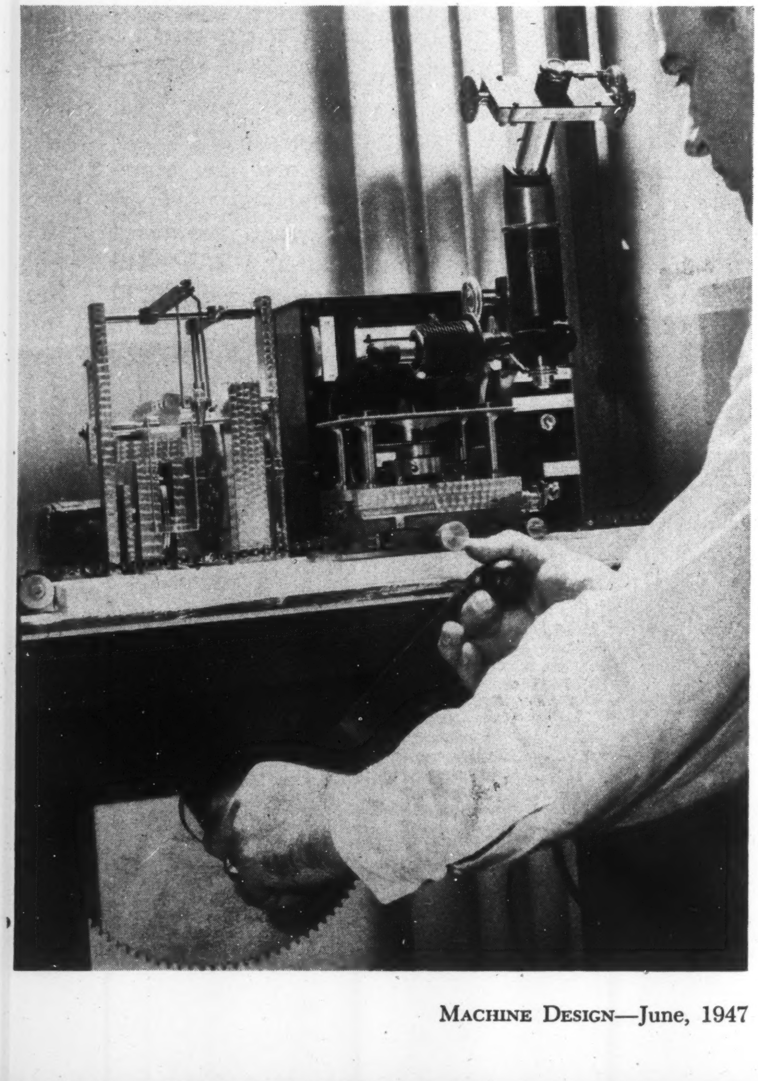
Variable-speed transmission, utilizing a differential and rolling ball system to provide speed adjustment, is illustrated at right. Designed by Joseph E. Anderson of the Charles M. Zust Co. the unit has input and output shafts connected through differential gearing as shown in the schematic drawing at right. The ball is adjustable so that its radii of contacts may be varied on cone disks both on the output shaft and on the differential carrier. This provides speeds on the output shaft from motor speed in one direction through zero to 10 per cent in the reverse direction.

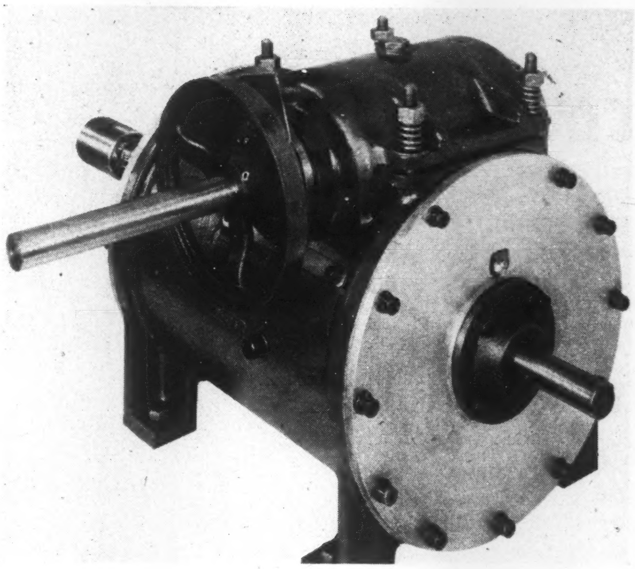
Referring to the diagrammatic drawing, a spur gear on the input shaft is meshed with a gear of the same size on a parallel jackshaft. On the jackshaft is a third gear, twice the diameter of the first and second gears, in mesh with a fourth gear of the same size on a second jackshaft. A fifth gear on this jackshaft meshes with a gear on the output shaft. This 1:1 planetary gear train is mounted in a cylindrical

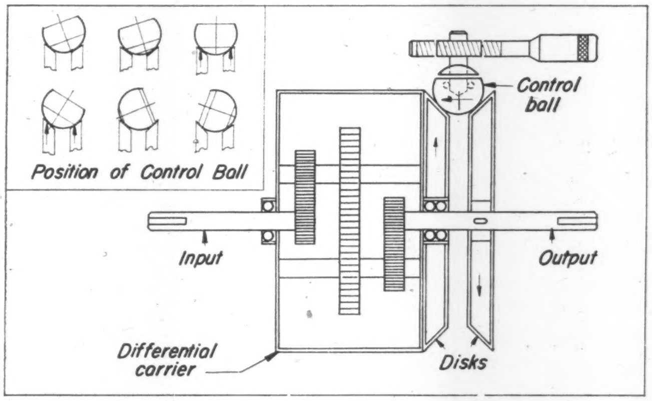
Measurement of hardness gradients within areas too small to permit satisfactory exploration with any of the usual hardness testers is made possible with the development of a microhardness tester perfected by the research laboratory of the United States Steel Corp. The tester shown at right measures hardness of the hardest steel constituents with amazing accuracy, determining the hardness of steel grains themselves as well as of the iron and other alloy carbides.

Mechanism consists of an indenter, 136-degree diamond penetrator, a mechanical stage for holding the specimen, a microscope for magnifying the test field from 500 to 1500 times, and a control box. With this instrument as many as 60 indentations may be made automatically at predetermined time intervals for surveying tiny gradients.

Depending on the hardness of the sample, indentations of the diamond may range upward of 2 microns in depth. The diamond point under a load of a few grams leaves a square mark, the diagonals of which are measured to determine the indentation. In the preparation of a specimen it is alternately polished to a mirror finish and etched until this dual process discloses no disturbed metal when observed under the microscope.







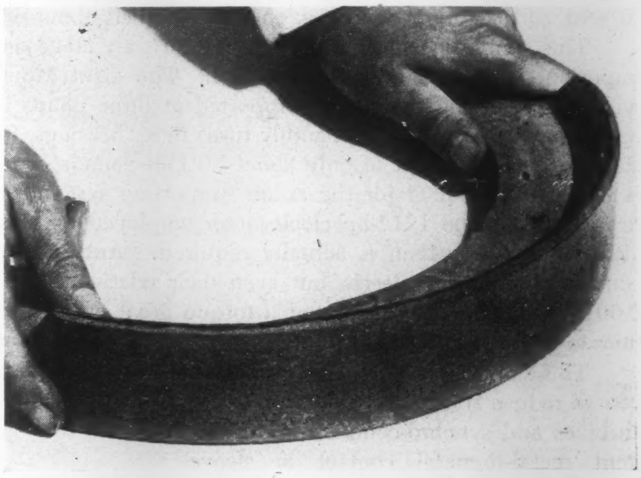
carrier which is free to rotate on the input and output shafts.

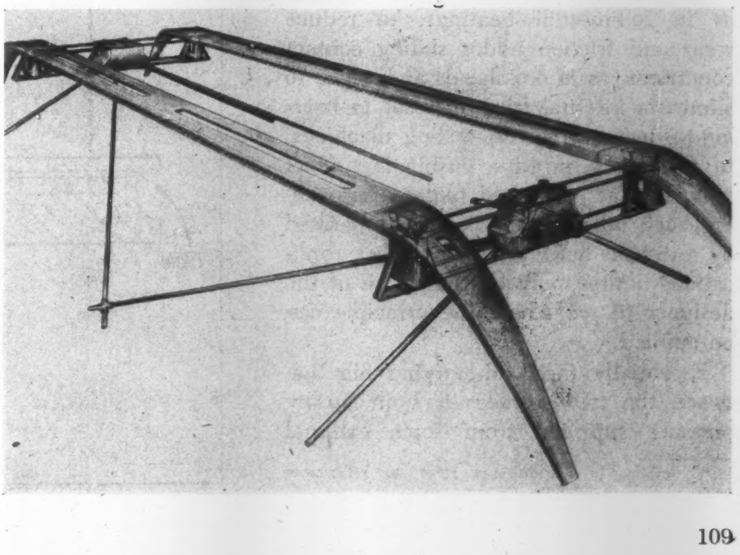
With the ball in the position shown, 50 per cent of the rotations will be dissipated by the counter rotation of the carrier. When the ball is positioned so that its vertical centerline contacts the disk fastened to the output shaft, the disk and shaft will not rotate, giving zero speed on the output shaft. By changing the ball centerline to the angular face of the differential carrier, this housing stands still, resulting in full speed on the output shaft. In this way the control ball, having an infinite number of radii combinations, gives an infinite number of speeds to the output shaft within the range of the unit.

Current collectors now in use on large electric locomotives flash considerably at high speed due to fluttering of the collector shoes. This fluttering is similar to the phenomenon which occurs in airplane wings. Wind tunnel tests and studies made by Westinghouse Electric Corp. resulted in design at right, making the shoe ride along the wire as smoothly at high speeds as at low speeds. Cutouts in the shoe itself reduce the lift coefficient and eliminate aerodynamic instability.

A leaf spring mounting, illustrated in the wash drawing, eliminates all pins and levers and places the effective center of rotation of the shoe above the wire instead of below it. This improves the stability and makes the leading edge of the shoe rotate away from the wire instead of "stubbing" into it when the shoe hits a rough spot.

Cemented bond between brake shoe and its lining, below, in a new process developed by Goodyear Tire and Rubber Co., replaces the riveting method of attachment in common use. This cementing process makes possible a larger contact area between lining and brake drum, resulting in better performance. Also, by eliminating rivets, the lining may be worn down to the shoe rather than only to the rivet heads, insuring longer brake lining life. Process consists of cleaning the shoe, applying cement to shoe and lining, drying, assembling under pressure, and curing at a specified temperature.





Hydrostatic Lubrication

By Dudley D. Fuller
Columbia University
New York

Part I–Oil-Pad Bearings

HIDDEN among the myriad of exhibits at the famous Paris Industrial Exposition in 1878 was one unpretentious and apparently useless creation which at best could only be classified as amusing. Yet, as time has shown, it was actually the forerunner of a great new development in lubrication, being one of the first examples of the application of hydrostatitcs to load-carrying, antifriction devices.

Called "Le Chemin de Fer de Glace" (Ice Railroad), this exhibit is said to have consisted of a large metal mass mounted on four legs having lion-like splayed feet. These feet rested solidly on a wide flat steel surface. Oil was pumped down each leg to the contacting surface of the foot with sufficient pressure to raise and, in a sense, float the entire mass. Friction between these feet and the flat plate was reduced almost to zero, so that the heavy block could be pushed about with the greatest of ease.

This simple idea has outgrown the curiosity stage and is today a most useful and important scientific and industrial tool. The giant Mount Palomar telescope, *Fig.* 1, weighing a million pounds, is supported at three points by hydrostatic pads, with the result that this great bulk smoothly turns in its bearings, following the path of the night stars with the exertion of only about 50 foot-pounds of torque. Coefficient of friction is less than 0.000004 for the entire supporting system, and the power required is extremely small, the 1/12-hp clock motor employed for this purpose providing considerably more power than is actually required. Antifriction bearings had been the first consideration in this design but even their relatively low coefficient of friction (about 0.001) would have necessitated a torque great enough to twist the frame beyond the minute tolerances that had to be maintained in the structure (1, 2, 3, 4, 5)*.

This same idea is used in step bearings taking thrusts at the ends of shafts; in oil lifts to reduce starting friction with heavy rotating machinery such as motor generators, turbines and synchro-condensers; to prevent metal-to-metal contact in sleeve bearings where rotational motion is too slow to produce or maintain an oil film, as in rolling-mill bearings; to reduce wear and friction under sliding contact conditions, as in crossheads and ways; to eliminate internal friction losses in bearing-testing and friction-testing machines; to provide a positive cushioning effect between flat or curved plates approaching each other when they are separated by a viscous fluid; and many other applications limited only by the vision of the designer to see where the principle can be applied.

Essentially the load-carrying film between the two surfaces is built up by pressure supplied from some external

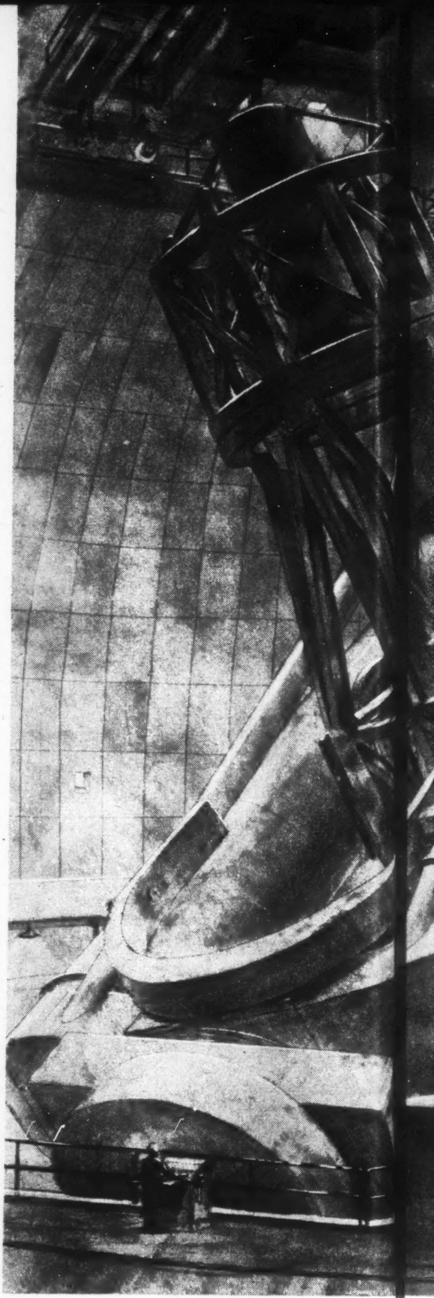


Fig. 1 — Two-hundred-inch telescope on Mount Palomar, weighing more than a million pounds, floats on hydrostatically lubricated bearings. Drawing, courtesy Calif. Inst. of Technology

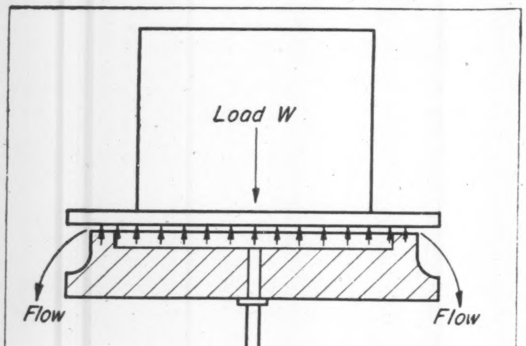


Fig. 2 — Left — Principle of the hydrostatically lubricated bearing carrying a vertical load

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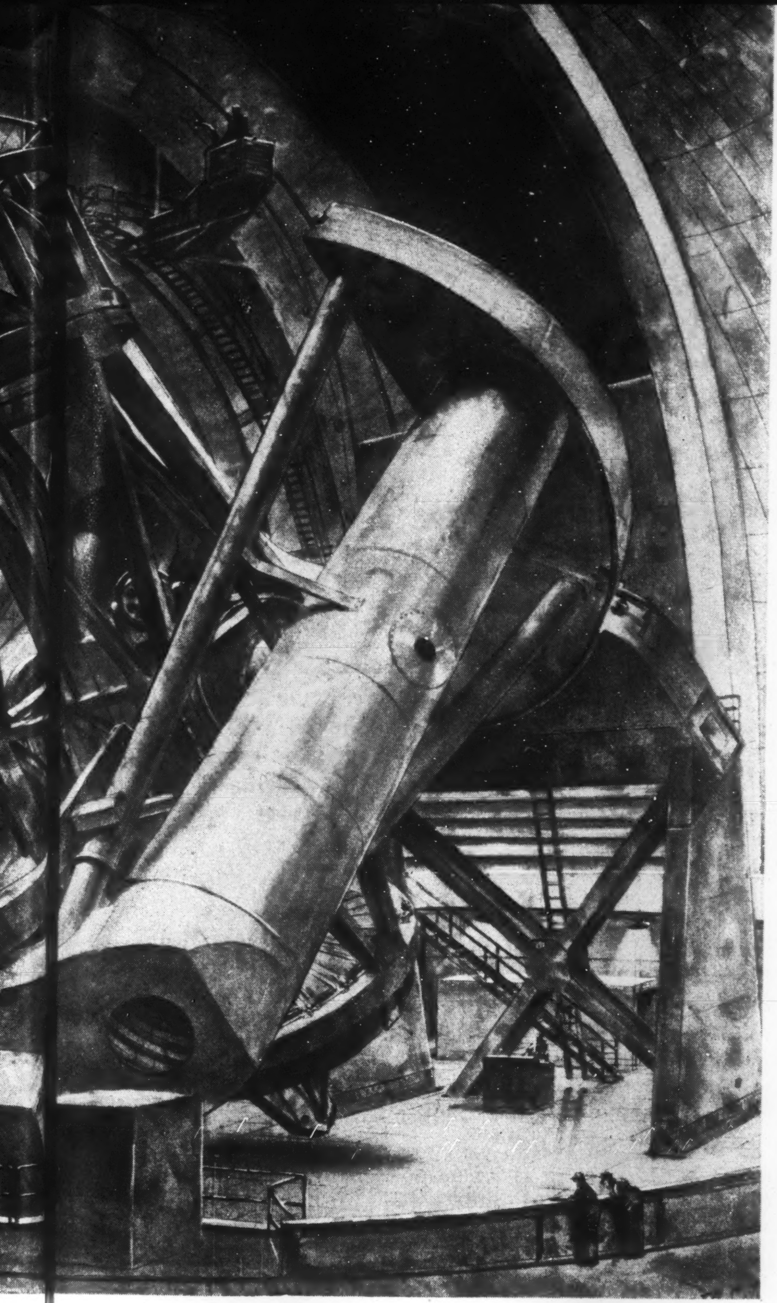
* Numbers in parentheses refer to references listed at end of article.



BEARING DESIGN PROBLEMS *involving unusual load and speed conditions may be solved by hydrostatic lubrication where conventional methods fail. This article inaugurates a noteworthy series covering the design and application of such bearings, including oil pad bearings, oil lifts and step bearings*

source, usually a pump, *Fig.* 2. Unlike a hydrodynamic film, this pressure film will be in existence whether the two surfaces have relative motion or not, and within the design limits there never can be metal-to-metal contact. When the two surfaces are separated by this kind of oil film the load is floated much as is a ship in water. It is the purpose of this series of articles to derive and illustrate the use of the equations upon which the design of such devices depends, so as to permit a quantitative evaluation of pressure required, film thickness produced, and quantity of oil that must be pumped.

The basic idea is merely a simple development of Sir Isaac Newton's original concept of viscous friction (6), which is expressed by the well known equation

$$F=\mu A\frac{dv}{dh} \qquad (1)$$

where F is the force that resists shearing at a surface of area A across which the velocity gradient is dv/dh, and μ is the coefficient of viscosity.

Quantity Flowing: To derive an expression for the quantity of fluid that must be pumped to sustain a given load, Equation 1 is applied to laminar flow of a viscous, incompressible fluid through a long rectangular slot where the width of the slot is great enough to allow neglect of end conditions, *Fig.* 3. Entrance and exit losses likewise are assumed small. Referring to *Fig.* 3, b is the width of the slot, l is the length and h the thickness. An elemental slug of width $2x$ is imagined to be extruded through the slot by the constant pressure difference causing flow. The depth of the actual shearing surface is indicated by dx and the corresponding velocity increment by dv. Downward force is

$$(P_1-P_2)\,b\,2x=\Delta P\,b\,2x$$

Upward force is

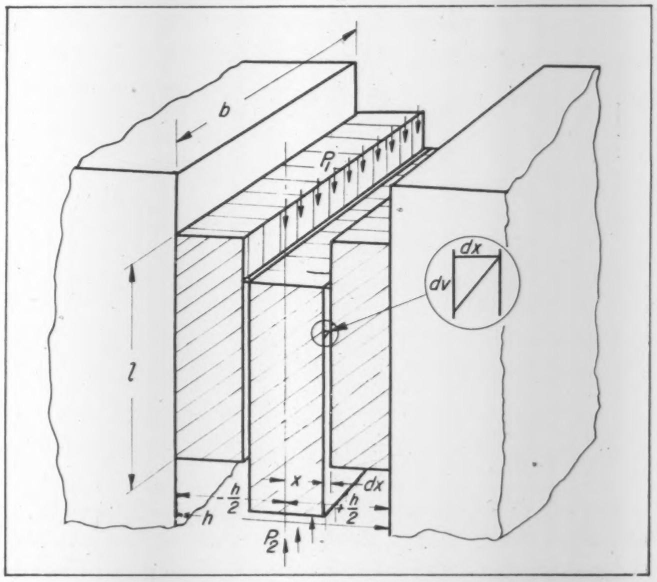
$$-\mu A\frac{dv}{dx}=-\mu\,2bl\,\frac{dv}{dx}$$

from Equation 1, the sign being minus because dv/dx is minus, that is, as x increases, v decreases. Equating forces,

$$2\,\Delta P\,b\,x=-\mu\,2bl\,\frac{dv}{dx}$$

from which, by factoring and rearranging,

Fig. 3—Diagram showing how small element of oil film is extruded by pressure difference acting upon it



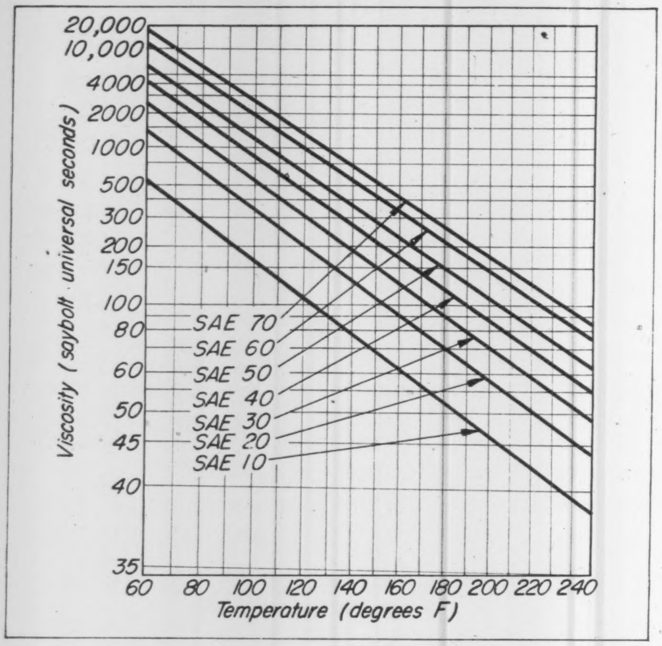


Fig. 4—Average viscosities, saybolt universal seconds, of typical SAE motor oils at various temperatures

$$dv=-\frac{\Delta Pxdx}{\mu\, l}$$

Integrating,

$$v=-\frac{\Delta P}{\mu l}\,\frac{x^2}{2}+C$$

To evaluate the constant, with laminar flow, when $x = \pm h/2$, $v = 0$, hence by substitution,

$$0=-\frac{\Delta P}{\mu l}\,\frac{h^2}{8}+C$$

and

$$v=\frac{\Delta P\,h^2}{8\mu l}-\frac{\Delta P\,x^2}{2\mu l}$$

which indicates a parabolic velocity distribution. Maximum velocity occurs when $x = 0$, that is,

$$v_{max}=\frac{\Delta P\,h^2}{8\mu l}$$

Average velocity, for parabolic distribution, is two-thirds of the maximum, or

$$v_{avg}=\frac{\Delta P\,h^2}{12\mu l}$$

Quantity of flow is equal to average velocity times area of cross section, $Q = v_{avg} \times hb$, which is equal to

$$Q=\frac{\Delta P\,h^3\,b}{12\mu l}\quad\ldots\ldots(2)$$

Viscosity Determination: Viscosity in the foregoing Equations 1 and 2 is in absolute units which depend upon the system of measurement employed. Using the English system the viscosity is in pounds-seconds per square inch (lb-sec-in.$^{-2}$), known as the reyn. In the c.g.s. system the viscosity is in dynes-seconds per square centimeter (dyne-sec cm^{-2}), known as the poise. A more practical unit is the centipoise, which is one-hundredth of a poise. Conversion between the English and c.g.s. systems is as follows:

$$\mu_{reyn}=1.45\times10^{-7}\mu_{centipoise}\quad\ldots\ldots(3)$$

Inasmuch as practical measurement is performed with a viscosimeter, the viscosity of commercial oils usually is reported in saybolt seconds universal (S.S.U.), *Fig.* 4. Conversion from saybolt seconds, *t*, to absolute viscosity involves the mass density of the oil, ρ, the relation being (7)

$$\frac{\mu}{\rho}=\nu=0.22t-\frac{180}{t}\quad\ldots\ldots(4)$$

where t is in seconds, μ is in centipoises and ρ is the mass density which, in the c.g.s. system, is equal to the specific gravity, *Fig.* 5. The ratio μ/ρ, denoted by ν, is called the kinematic viscosity, the units in this case being centistokes. A table for the conversion in Equation 4 is given in the ASTM standards on Petroleum, D 446-37T.

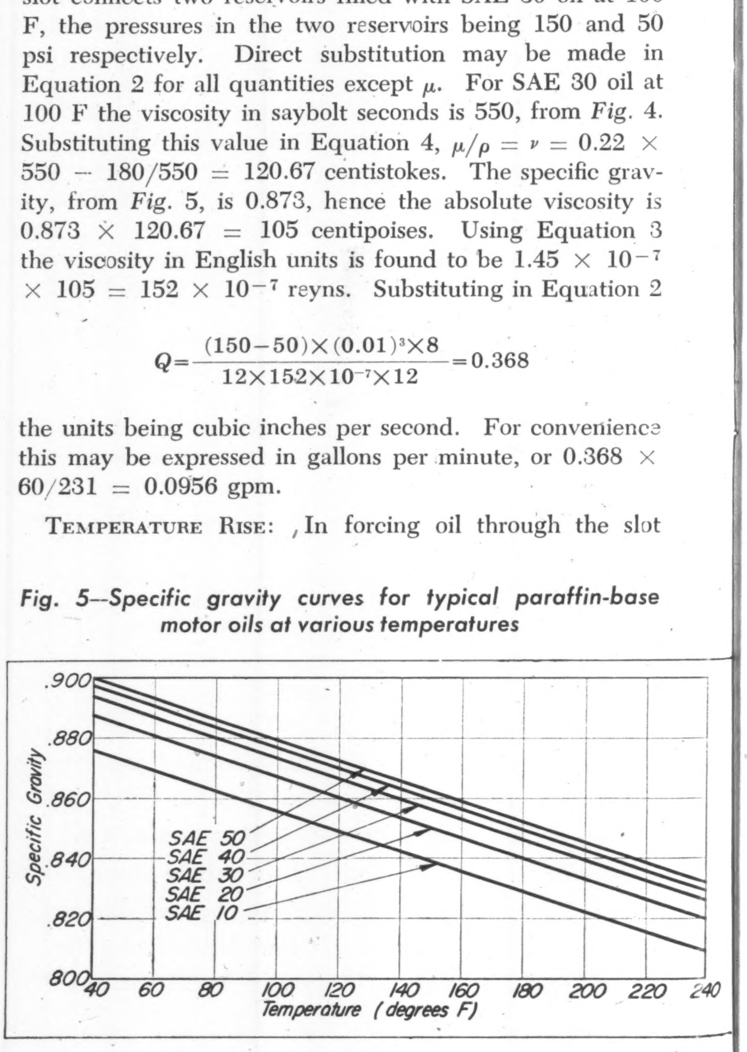
Example: To illustrate the application of the foregoing relations, the flow through a slot 8 inches wide, 0.01-inch thick and 12 inches long will be calculated. The slot connects two reservoirs filled with SAE 30 oil at 100 F, the pressures in the two reservoirs being 150 and 50 psi respectively. Direct substitution may be made in Equation 2 for all quantities except μ. For SAE 30 oil at 100 F the viscosity in saybolt seconds is 550, from *Fig.* 4. Substituting this value in Equation 4, $\mu/\rho = \nu = 0.22 \times 550 - 180/550 = 120.67$ centistokes. The specific gravity, from *Fig.* 5, is 0.873, hence the absolute viscosity is $0.873 \times 120.67 = 105$ centipoises. Using Equation 3 the viscosity in English units is found to be $1.45 \times 10^{-7} \times 105 = 152 \times 10^{-7}$ reyns. Substituting in Equation 2

$$Q=\frac{(150-50)\times(0.01)^3\times8}{12\times152\times10^{-7}\times12}=0.368$$

the units being cubic inches per second. For convenience this may be expressed in gallons per minute, or $0.368 \times 60/231 = 0.0956$ gpm.

Temperature Rise: In forcing oil through the slot

Fig. 5—Specific gravity curves for typical paraffin-base motor oils at various temperatures



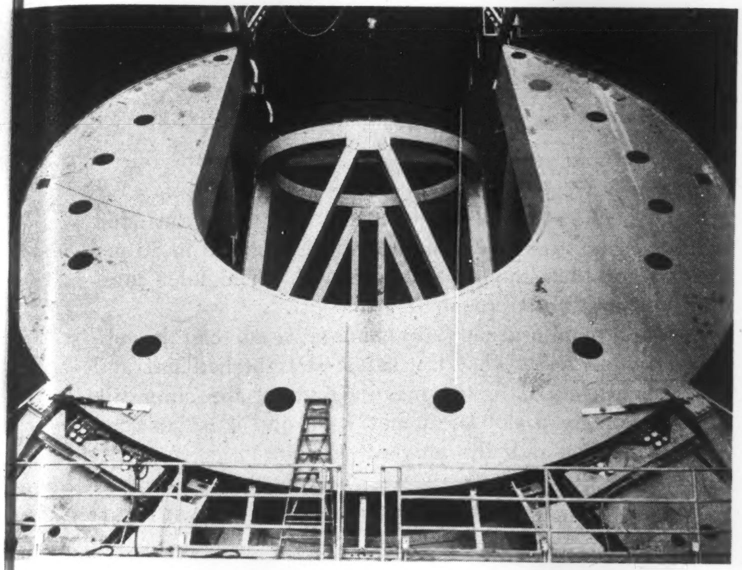


Fig. 6—View of the horseshoe element of the 200-inch telescope, showing the oil pads at lower left and right. Photo, courtesy California Institute of Technology

against the viscous resistance to flow, some temperature rise will result. If all of the friction losses except those in the pump appear in the oil as a temperature rise, then the energy is equal to $Q\,\Delta P$ where Q is flow in cubic inches per second, and ΔP is pressure difference in psi. To convert this energy, which is in inch-pounds, to heat units it is necessary to divide by the mechanical equivalent of heat, m inch-pounds per Btu, hence the energy in Btu is

$$\frac{Q\,\Delta P}{m}$$

where m, for the units here used, is equal to 778×12. The heat energy corresponding to temperature rise is

$$Q\,\Delta T\,\gamma\,S$$

where ΔT is the temperature rise, degrees F, γ is the weight density in pounds per cubic inch, and S is the specific heat in Btu per lb deg F. Equating the two

$$\frac{Q\,\Delta P}{m} = Q\,\Delta T\,\gamma\,S$$

from which

$$\Delta T = \frac{\Delta P}{m\,\gamma\,S} \qquad (5)$$

To find the temperature rise in the foregoing example, the weight density is $\gamma = 0.873 \times 62.4/1728 = 0.0315$ lb per cu in., while the specific heat is approximately 0.5 Btu per lb deg F, hence

$$\Delta T = \frac{100}{778 \times 12 \times 0.0315 \times 0.5} = 0.7\,\mathrm{F}$$

If the pump efficiency is less than 100 per cent, and there is no cooling of the oil, the temperature rise will be greater, and equal to the foregoing value divided by the pump efficiency. Thus, if the efficiency is only 50 per cent, the rise would be $0.7/0.5 = 1.4$ F for each 100 psi of pressure difference. With normal conduction and convection the actual temperature rise will be less and in many cases the effect of this temperature rise on the viscosity of the oil may be neglected.

When the pressure acting is of the order of several thousand psi, its effect on viscosity should be considered. High pressures will increase the viscosity and reduce the flow below the quantity that would be calculated if this effect were ignored (8). The modified equation to include pressure effect will be developed later.

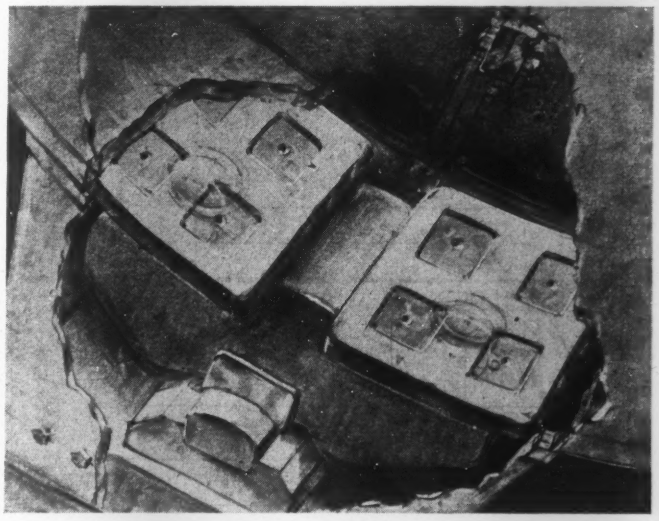
APPLICATION TO MOUNT PALOMAR TELESCOPE: The giant 200-inch telescope, largest in the world, now being erected for the California Institute of Technology incorporates in its bearing design this principle of hydrostatic lubrication. Equation 2 is the only equation necessary for the design or evaluation of these bearings.

In *Fig.* 1 is shown the three-point suspension used to carry the yoke. At the north end under the horseshoe are two sets of pads, each of which consists of two pads as can be seen in *Fig.* 6. At the south end three similar pads are curved to fit against the surface of a hemisphere, providing the complete support.

The horseshoe itself has a radius of 23 feet and applies a load of about 164,000 lb to each individual pad under its rim. The pads are 28 inches square, designed so as to be equalizing and self-aligning with a babbitted surface curved to match the horseshoe rim. In each pad are four 7-inch by 7-inch recesses to which oil from a constant-displacement pump is supplied through orifices, *Fig.* 7.

Use of separate recesses and orifices is an important consideration in this type of design. Presumably the entire area could have been relieved and supplied with only one oil line, but then if the load were not at all times perfectly centered, a tipping action could take place with the supporting fluid flowing out one side and the other edge not being raised at all, *Fig.* 8*a*. This is prevented by the insertion of restricting orifices in separate recesses. If tipping occurs at one corner for some reason, flow of

Fig. 7—Detail of two of the hydrostatically lubricated bearing pads supporting the 200-inch telescope. Drawing, courtesy The Franklin Institute



oil is restrained by that orifice so that pressure in the other recesses is maintained and metal-to-metal contact prevented, *Fig. 8b*. A needle valve makes a satisfactory adjustable orifice. With certain other applications a separate pump can be used for each recess, producing the same effect.

Assuming that a film thickness of 0.005-inch would be desirable in the telescope bearings for safety, using an SAE 20 oil, the quantity that should be pumped at 60 F, and the inlet pressure required, may be calculated as follows.

In *Fig.* 9 the high-pressure area is indicated by A, and the sill area across which the oil will flow by B. Neglecting corner effects on oil flow, the pressure drop across the sill will be linear, varying from pump inlet pressure at the inner edge to atmospheric at the outer. The average pressure on this sill will then be one-half of maximum.

Areas may be calculated from the dimensions on *Fig.* 9. Thus, high pressure area $A = (7 + 6 + 7)^2 = 400$ sq in., and sill area $B = 28^2 - 400 = 384$ sq in. If P_0 is the inlet pressure, then

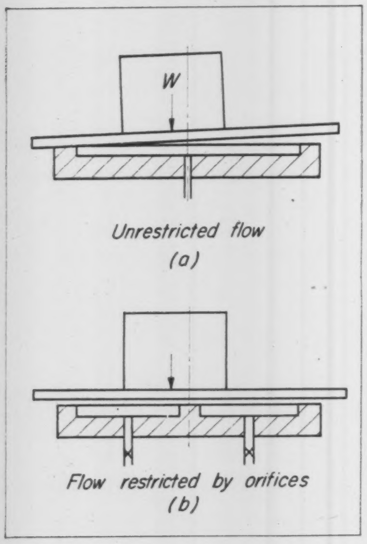


Fig. 8—Left—How multiple recesses, with flow restricted by orifices, prevents tilting of the load and possible metallic contact

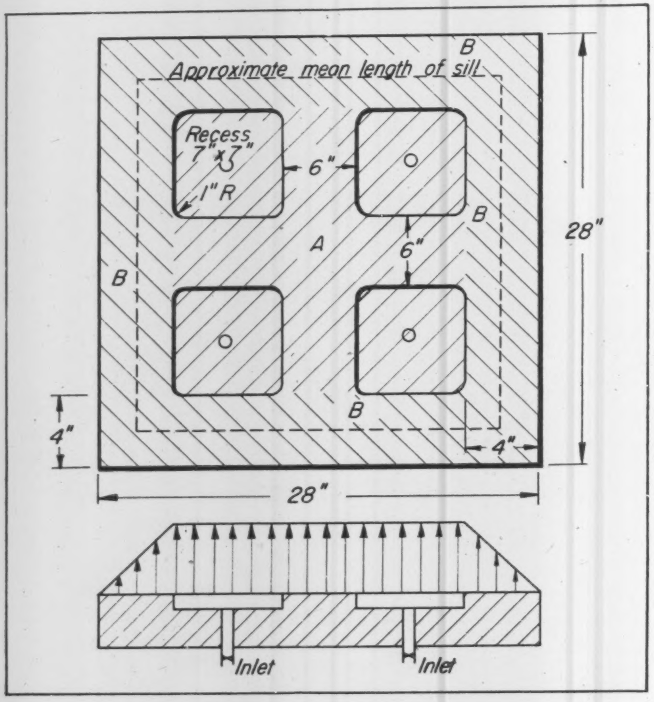


Fig. 9—Below—Dimensions of one bearing pad for the 200-inch telescope showing, in the lower view, the approximate pressure distribution over the pad

$$164{,}000 = P_0(400) + \frac{P_0}{2}(384)$$

from which $F_o = 277$ psi.

It has been established by test that the pressure needed to raise a load after a standing period is from 20 to 30 per cent higher than the running pressure. The inlet pressure will then be approximately 360 psi.

Using Equation 2 an approximate value can be obtained by assuming that the sill is straightened out and has a length equal to the mean length of the outer sill. This is actually a slot 96 inches wide and 4 inches long with oil flowing radially outward, *Fig.* 9.

For SAE 20 oil at 60 F the viscosity is 1400 saybolt seconds, *Fig.* 4, hence the kinematic viscosity, from Equation 4, is $\nu = 0.22 \times 1400 - 180/1400 = 307.9$ centistokes.

From *Fig.* 5, $\rho = 0.88$, hence $\mu = 307.9 \times 0.88 = 271$ centipoises, which is equal to $271 \times 1.45 \times 10^{-7}$ reyns $= 393 \times 10^{-7}$ reyns. From Equation 2 the oil flow is

$$Q = \frac{360 \times 0.005^3 \times 96}{12 \times 3.93. \times 10^{-7} \times 4} = 2.29$$

in cubic inches per second, which is equal to 0.595 gpm, for each pad, or a total of 2.38 gpm for four pads.

Frictional drag and coefficient of friction in this type of bearing naturally depend upon sliding velocity, the lower limit being zero with no motion. If, for example, a speed of one revolution in twenty-four hours is assumed as the operating speed of the telescope, the peripheral velocity at the circumference of the 46-foot diameter horseshoe will be 0.02-in. per sec.

Tangential friction drag can be obtained directly from Equation 1 by summing the force of the sill area with its film thickness and that of the recess area with its film thickness or, as a safe approximation, using the entire area without including the effect of the deeper, 3/16-inch, film in each recess. Using the latter method,

$$F = \mu A \frac{dv}{dh}$$

$$= \frac{393 \times 10^{-7} \times 28^2 \times 0.02}{0.005} = 0.1233 \text{ lb}$$

This corresponds to a coefficient of friction equal to $0.1233/164{,}000 = 0.00000075$, or $f = 7.5 \times 10^{-7}$ for the foregoing conditions.

There will be two contributions to the temperature rise of the film, one produced by the high pressure oil extruding outward throughout the slot as developed in Equation 5, and the other due to the shearing of the oil film by relative motion of the bearing parts.

Energy dissipated by the latter effect will be equal to FV, where F is the resisting shear force of the film from Equation 1, in pounds, and V is the relative velocity in inches per second. In heat units (Btu) the energy is

$$\frac{F\,V}{m}$$

Substituting for F from Equation 1 the energy is

$$\frac{F\,V}{m}=\frac{\mu\,A\,V}{h}\times\frac{V}{m}$$

Adding this to the heat generated by the extruding oil and equating to the heat corresponding to the temperature rise,

$$\frac{Q\,\Delta P}{m}+\frac{\mu\,A\,V^2}{h\,m}=Q\,\Delta T\,\gamma\,S$$

from which

$$\Delta T=\frac{\Delta P}{m\,\gamma\,S}+\frac{\mu A\,V^2}{m\,h\,Q\,\gamma\,S}\;\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\;(6)$$

In this particular example the second term will be negligible and since, in the previous example, it was found that temperature rise was 1.4 F per 100 psi pressure difference with a pump efficiency of 50 per cent, the value of ΔT becomes 360 × 1.4/100 = 5 F.

MILLING MACHINE SLIDE: Another interesting application is shown in *Fig.* 10†. Tubular table ways used on a large milling machine are literally made to float by hydraulic pressure. These tubes slide in mating semicircular bedways, and the table is floated by introducing oil into the closed tubes under pressure. The figure shows the pressure inlet and arrangement of drilled holes. As these holes move past the pressure inlet in the machine bed, oil enters the tube which becomes its own oil reservoir. By maintaining a high pressure at the inlet, oil escapes in sufficient quantity from the multiplicity of holes along the length of the tube to maintain continuous support for the massive table. The continuous flushing action of the lubricant along the bedways prevents accumulation of foreign matter.

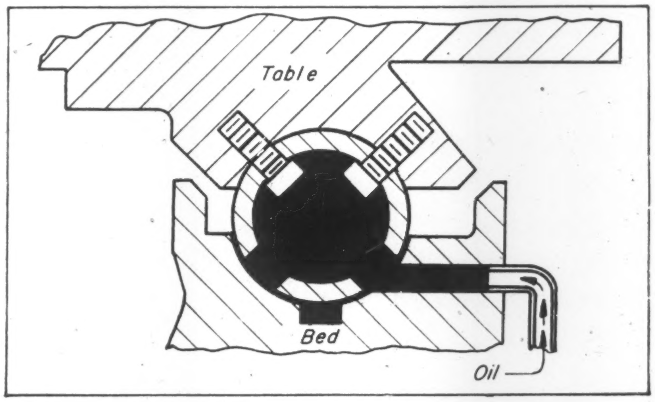


Fig. 10—Hydrostatically lubricated way on Ingersoll milling machine; oil is fed under pressure to interior of tube

In certain kinds of bearing-testing equipment where internal friction of the machine itself must be eliminated, the hydrostatic principle finds many applications. The Texas Co. has developed a machine for general-purpose testing and research use, called a Universal Bearing-Testing Machine, *Fig.* 11. Load is applied by means of a hydraulic cylinder and yoke to the bottom of the bearing through a loading block. As the shaft turns, the frictional torque between shaft and bearing is evaluated by measuring the force exerted against a weighing scale placed at the end of the friction arm. By supplying high-pressure oil to a set of reliefs at the surface between the shoe and bearing holder, the two surfaces can be separated and the frictional drag reduced to zero. By proper proportioning of the relief area to the cross-sectional area of the loading cylinder, the high-pressure pump employed for applying load can be used to float the shoe, and the surfaces will automatically be separated for as long a time as the machine is in operation.

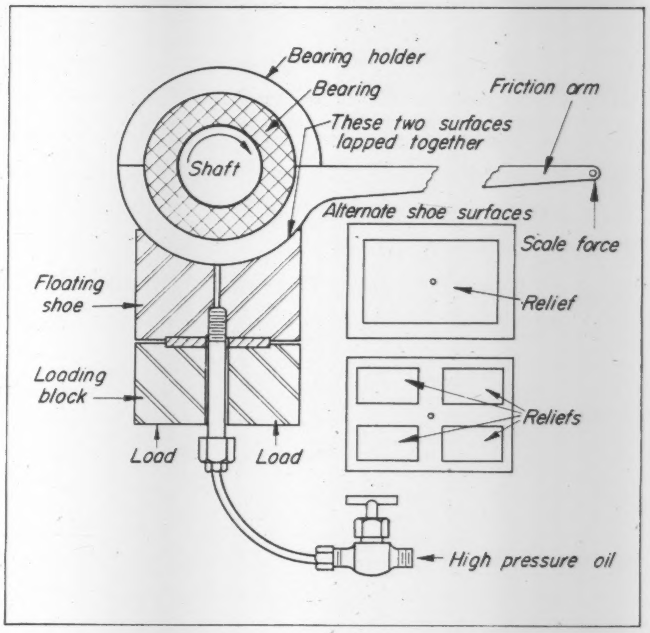


Fig. 11—Hydrostatic lubrication is applied between floating shoe and bearing holder of universal bearing testing machine. Drawing, courtesy The Texas Co.

HIGH-PRESSURE APPLICATION: It is a well known fact that many common lubricants, including petroleum-base lubricants, undergo considerable increase in viscosity when subjected to high pressures. Some oils actually become plastic solids at pressures from 20,000 to 30,000 psi. It has been found that the relationship between viscosity and pressure is very closely logarithmic and can be expressed by

$$\mu_p=\mu_0 e^{Bp}\;\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\;(7)$$

where p is pressure in psi, μ_p is viscosity at pressure p, μ_0 is viscosity at atmospheric pressure, and B is an experimental constant.

Typical values for B (8), are as follows:

Oil	Temp.	B
An SAE 30	100 F	2.2×10^{-4}
An SAE 10	100 F	1.6×10^{-4}
A Castor Oil	100 F	1.0×10^{-4}

For example, considering the SAE 30 at 100 F and 2000 psi, substitution in Equation 7 shows $\mu_p = \mu_0 e^{2.2 \times 10^{-4} \times 2000} = \mu_0 e^{0.44} = \mu_0 \times 1.55$, indicating that the viscosity is about 1½ times that at atmospheric pressure.

This increase in viscosity will affect flow so that Equa-

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† Discussed in an article on "Improving Design with Tubular Sections" by Roger W. Bolz, MACHINE DESIGN, June, 1945.

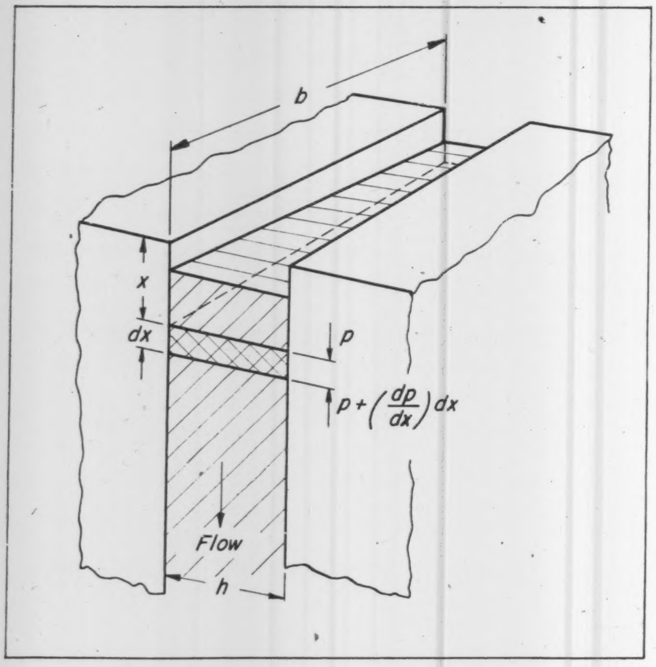

Fig. 12—Pressure gradient in oil film must be considered when pressure is high enough to affect viscosity

tion 2 is no longer satisfactory for such conditions. To include pressure effect on viscosity, the elemental volume shown in *Fig.* 12 will be considered. The flow through this differential volume, if the change in pressure can be evaluated, is given by Equation 2:

$$q=\frac{\Delta p\, b\, h^3}{12\,\mu_p\, dx}$$

but

$$\Delta p=p-\left[p+\left(\frac{dp}{dx}\right)dx\right]=-\left(\frac{dp}{dx}\right)dx$$

Substituting for Δp and for μ_p

$$q=\frac{-\dfrac{dp}{dx}b\,h^3}{12\,\mu_o e^{Bp}}$$

which may be written

$$\frac{12\,\mu_o q\, dx}{b\,h^3}=-\,e^{-Bp}dp$$

Integrating,

$$\frac{12\,\mu_o q\, x}{b\,h^3}=\frac{1}{B}e^{-Bp}+C$$

To evaluate the constant, when $x = O$, $p = p_o$, then $C = (1/B)e^{-Bp_o}$. Substituting,

$$q=\frac{b\,h^3}{12\,\mu_o\, x\, B}-\left[-e^{-Bp_o}+e^{-Bp}\right]$$

Now if p at any value of x is known, the flow can be evaluated. Using $x = l$ and $p = O$,

$$Q=\frac{b\,h^3}{12\,\mu_o\, l}\left[\frac{1-e^{-Bp_o}}{B}\right]\quad\dots\dots\dots\dots(8)$$

Similarity between this equation and Equation 2 should be noted. The bracketed term in Equation 8 replaces ΔP of Equation 2.

EXAMPLE: Considering the slot used in the earlier example, with a pressure differential of 2000 psi and the same oil, substitution in Equation 8 gives

$$Q=\frac{8\times 0.01^3}{12\times 150.8\times 10^{-7}\times 12}\left[\frac{1-e^{-2.2\times 10^{-4}\times 2000}}{2.2\times 10^{-4}}\right]$$

$=5.96$ cu. in per sec

Comparing this with the use of Equation 2, which neglects pressure increase of viscosity,

$$Q=\frac{8\times 10\times 10^{-7}\times 2000}{12\times 150.8\times 10^{-7}\times 12}$$

$=7.37$ cu in. per sec

which is almost 25 per cent greater than the value obtained from Equation 8. It is obvious that if oil pressures are relatively high, the pressure effect on viscosity should be included when estimating flow or leakage.

As the pressure becomes very large, greater for example than 10,000 psi, the quantity of oil flow becomes proportionately less and approaches a limiting condition where the flow is largely independent of pressure. Thus as p increases, e^{-Bp} decreases and Q approaches $bh^3/12\mu_o lB$ as a constant limiting value.

All original assumptions on which the derivation of these equations are based must still be satisfied. In particular, flow should remain laminar and B retain a constant value. Absence of turbulent flow can be checked by computing Reynolds number for the application under consideration. Values of Reynolds number below 2000 are usually considered to indicate viscous flow. In this analysis the factor B was assumed to be constant. Actually it decreases somewhat as pressure increases but up to roughly 10,000 psi the variation from a constant value is small and a single value can be assigned to B without introducing appreciable error (9).

Design of oil lifts, step bearings and other load-carrying devices based on the principles of hydrostatic lubrication will be discussed and illustrated in subsequent articles.

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D-C Relays

. . . for motor control and how to apply them

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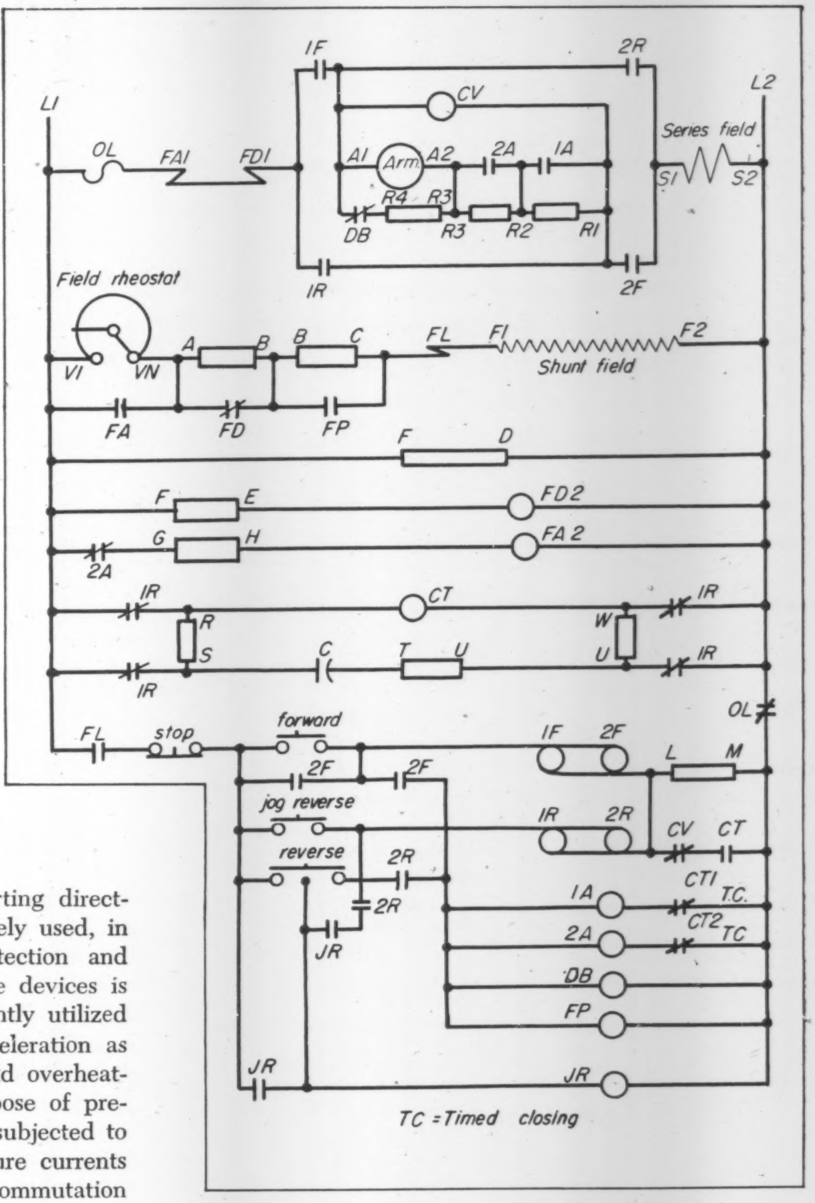


Fig. 1—Above—Reversing controller circuit with dynamic braking

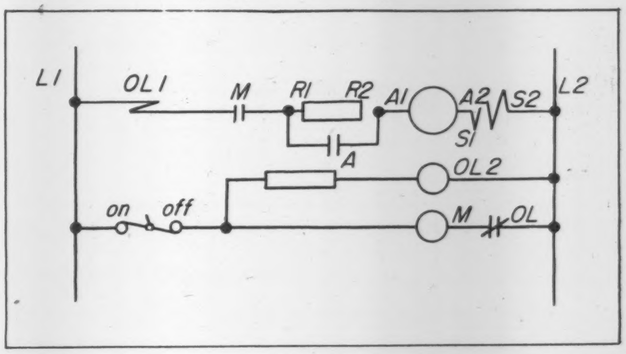
IN ADDITION to the various relays used for starting direct-current motors, there are a number of relays widely used, in different combinations, to provide running protection and special control functions. The most common of these devices is the overload relay. However, other relays are frequently utilized to protect a motor during field acceleration and deceleration as well as against accidental plugging, field loss and field overheating, *Fig*. 1. All of these are employed for the purpose of preventing motors from becoming too hot or from being subjected to excessive inrushes of armature current. Heavy armature currents not only result in undue heating, but also cause commutation trouble.

Overload Relays: These relays are of two general types—thermal and magnetic. The thermal overload relay is designed to follow, as closely as possible, the motor temperature changes, and to operate at the point where the motor exceeds its maximum allowable temperature rise. It permits temporary overloading, which is often advantageous; however, on prolonged overloads, it will function when the motor becomes too hot. One disadvantage of this type of relay is that it usually will not trip fast enough on sudden, severe overloads which cause commutation difficulty.

The other basic overload relay is of the magnetic type and provides instantaneous trip, or a slightly delayed trip by means of a dashpot timer. This relay is usually adjustable so that it can be set to trip at from 125 to 175 per cent of full-load motor current. The relay will not trip on the starting inrush, either because of the time delay, or due to being set above this value. However, should the motor stall, or be subjected to a severe overload, it will trip fast enough to prevent damage to the motor. Obviously this type of relay cannot protect the motor on prolonged overloads of less than the value for which it is set.

Usually, the thermal overload relay does not reset automatically. It is, therefore, suitable for both two-wire and three-wire control circuits. The magnetic type, however, is inherently a

Fig. 2—Below—Circuit utilizing two-coil magnetic overload relay



resetting device, that is, its contacts reclose when the overload is removed. It is suitable only for three-wire applications where interruption of the circuit will stop the motor. On two-wire control circuits, the contactor would be re-energized if the overload were to reset automatically and "telegraphing" would take place.

The magnetic overload relay is sometimes equipped with a mechanical latch so that it must be manually reset, thus making it suitable for two-wire control circuits. An electrical method for accomplishing the same thing is shown in *Fig.* 2. In addition to the series operating coil OL 1, the relay has a shunt holding coil OL 2. The holding coil keeps the overload contacts from reclosing once the relay has operated. The two-wire pilot device must be opened to reset the circuit. It should be pointed out that it is sometimes a convenience to have automatic reset on an overload relay, particularly when the control cabinet is rather inaccessible.

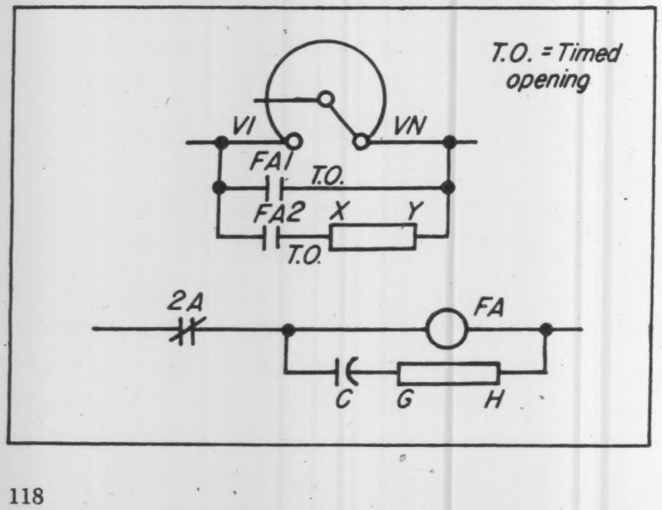
Load Characteristics Determine Relay Type

Selection of the proper overload relay depends upon the nature of the motor load. For example, a grinding wheel drive motor would be protected best by the thermal type, since the danger of stalling or of sudden, severe overloads is slight, but prolonged lesser overloads are possible. On the other hand, the drive for a traveling mechanism, such as a crane, is much more likely to be subjected to severe overloads where the instantaneous device will give better protection. On some applications it is desirable to use a combination of both overloads in order to obtain adequate protection.

Field Acceleration: Field acceleration or deceleration refers to the controlled weakening or strengthening of the motor shunt field to prevent excessive armature current. During the starting of a direct-current motor the field is kept at full strength while the armature resistor is being commutated. This provides maximum torque for acceleration to base speed. If there is a rheostat in the field circuit, it is inserted after the last accelerator closes. Before discussing the various ways in which this can be done, it may be desirable to review why such controlled handling of the field is necessary.

On a motor having a 4:1 speed range the base speed is obtained with rated armature voltage and full-field strength. The top speed of four times base speed is obtained by weakening the field flux to one-fourth of its base-speed value.

Fig. 3—Capacitor-timed field acceleration



If the field could be weakened instantaneously with the motor running at base speed, the counter voltage would immediately drop to about one-fourth rated voltage, and the unbalanced line voltage would cause a high armature current limited only by the resistance in lines and motor.

Due to inductance, motor fields cannot change instantaneously but have an inherent lag. Some motors are intentionally designed to have highly inductive or "slow" fields so that field acceleration devices can be eliminated. If the field change is not too fast, and if there is not too much inertia in the motor and load, the speed change can follow the field change, thus supporting the induced counter voltage and preventing the armature current from becoming excessive. In this case the field might be weakened at the time the last armature accelerator closes. However, on a wide-speed-range motor where the field is not exceptionally slow or where the inertia of the motor and load is high, a field accelerating device is required.

The field can be weakened by a timing relay providing one or more steps. A partial circuit for such a scheme is shown in *Fig.* 3 as a supplement to *Fig.* 1, which shows a complete controller. The normally-open contacts of relay FA open a definite time after the last accelerator closes. Contact FA 1 opens first, inserting the parallel combination of resistor XY and the rheostat into the field circuit.

Resistor XY is selected to be approximately equal to the total rheostat ohms. Therefore, the maximum resistance that could be added on the first step would be one-half the rheostat ohms. When the second contact FA 2 opens, the entire rheostat is inserted.

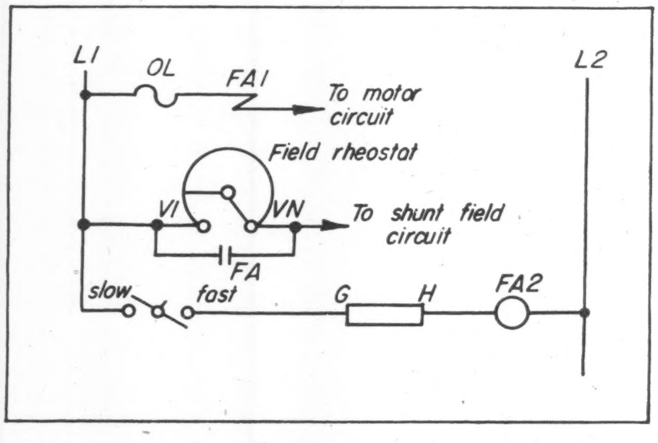


Fig. 4—Combined accelerating and decelerating relay for a specific application

Once such a timed relay functions during the starting period, it is no longer effective. That is, if the field should be weakened manually while the motor is running, the relay would not operate, even though the inrush caused might be high. This is usually not a serious objection because the rapid operation of a field rheostat is not a normal operating condition.

A different means of field acceleration has been illustrated in *Fig.* 1. Here the relay has been provided with two coils which normally aid each other. The setting specification is that the shunt coil FA 2 must pick up the relay. With the shunt coil disconnected, the series coil FA 1 should pick up the relay on 125 per cent of the full-load current and drop it out on 100 per cent.

Relay Vibrates During Acceleration

With definite time of armature acceleration, the armature current can, and usually does, drop below the full-load value on each accelerating step. During this time, the shunt coil keeps the FA relay closed, since this coil is not disconnected until the last accelerator closes. The same coil serves to close FA during dynamic braking to insure maximum braking effect.

After the last accelerator closes, the current in the series coil keeps the FA relay closed until this current drops to rated motor amperes. At that time the relay opens and inserts the rheostat. The inrush caused by inserting the rheostat will close the FA relay, thereby strengthening the field again. The relay vibrates in this manner until the motor has accelerated.

Since the series coil is in the running circuit at all times, the FA relay will function if manual operation of the rheostat causes an inrush of 125 per cent or more. Of course, inrushes of this value due to a sudden load would also operate the relay and strengthen the field. On applications where this might be objectionable, the definite timed field acceleration previously described should be used.

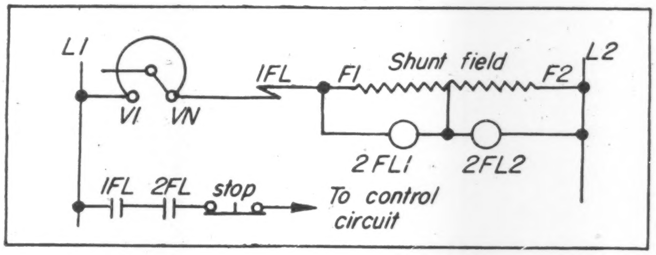


Fig. 5—Two-relay scheme for field-failure protection on wide current ranges

Another common variation of the two-coil vibrating type relay incorporates another series coil instead of the shunt coil. This second series coil, referred to as the starting coil, is placed in series with the last step of the accelerating resistor so that it is cut out by the last accelerator. The starting coil can be designed to furnish a relatively large number of ampere-turns, because its duty cycle is short. During starting, it adds to the running coil, insuring that the relay remains closed even when the current drops far below 100 per cent. This starting coil can, at the same time, be included in the dynamic braking circuit to keep the relay closed until the dynamic current has dropped to a low value. The running coil, however, would not be in the circuit.

On current-limit motor acceleration, the armature current does not go below 100 per cent during starting. For this type of starter, the FA relay could have a single series coil. Then the relay would not serve the alternate purpose of strengthening the field for dynamic braking but would be entirely satisfactory for field acceleration alone.

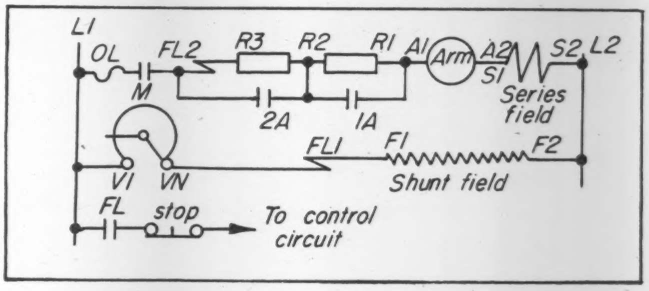


Fig. 6—Compound field-failure relay

Field Deceleration: Field deceleration, caused by strengthening the field, produces an opposite effect to acceleration. The increase in field strength, when the motor is running above base speed, causes the counter voltage to rise. Unbalanced counter voltage may become several times the line voltage if the motor is operating at top speed. The current inrushes are therefore opposite to the normal direction of current, and power is supplied back to the line during this deceleration.

The field decelerating relay FD shown in *Fig.* 1 has two coils. The shunt coil FD 2 is connected across the line and polarizes the relay. The series coil FD 1 opposes the shunt coil when current flows in the normal running direction. Current in this direction should never cause the relay to operate and, for testing purposes, it is usually specified that the relay must not pick up on currents up to 200 per cent of full load. When the current in coil FD 1 reverses during deceleration, the effect of this coil adds to the shunt coil FD 2. The relay is set to operate at about 50 per cent current in the reverse direction. The reason for keeping this value low is that a motor usually will not commutate as well when acting as a generator. Also, the 50 per cent current setting is high enough for all practical considerations.

The FD relay inserts in series with the field a resistance equal to approximately two-thirds of the total rheostat ohms. This reduces the counter voltage and, in turn, the pump-back current, so that the relay will drop out and strengthen the field again. Thus, this relay vibrates in much the same manner as the field accelerating relay until the motor has decelerated.

Relay Used for Both Acceleration and Deceleration

Employment of a single relay for both accelerating and decelerating is shown in *Fig.* 4. The application is special in that it incorporates a selector switch to provide either the preset rheostat speed or the base speed operation of the motor. With the selector on "fast", the shunt coil FA 2 is not in the circuit. Therefore, acceleration is accomplished entirely with the series coil FA 1. The setting is, of course, 125 per cent pick-up and 100 per cent drop-out. As previously mentioned, such a single coil scheme should be applied only to motor starters where the starting current does not drop below 100 per cent.

If the motor is running at high speed and the selector is changed to "slow", the shunt coil is energized, thus picking up the relay and shorting the rheostat. The resulting pump-back current in the series coil opposes the shunt coil, which causes the relay to drop out momentarily and weaken the field again. In this way both field accelera-

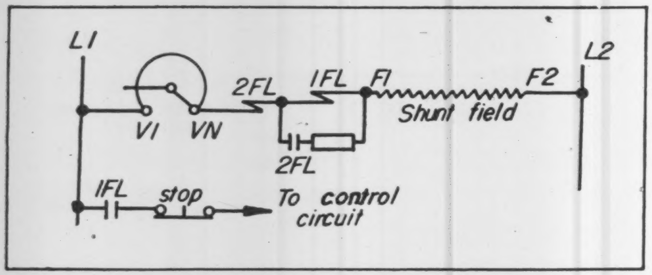


Fig. 7—Differential field-failure relay

tion and deceleration are obtained.

Field decelerating protection is essential principally on those applications where rapid change in speed is a normal operation, or on large motor installations where damage to the machine might result from excessive current. Usually, when field decelerating control is required, it can be assumed that vibrating type field acceleration is necessary for the same reasons.

Nonplugging: Connection of the motor armature to opposite polarity before the motor slows down is done on certain special drives to stop or reverse the motor as quickly as possible. Such an operation requires the addition of a special current-limiting resistor, with means for commutating it, since the counter voltage adds to the line voltage under this condition, and the normal starting resistor is not sufficient.

General purpose direct-current motor drives do not require plugging. However, when the plugging resistor and its associated control are omitted, it is necessary to protect against accidental plugging, such as would occur if the opposite directional pushbutton were operated immediately after the stop pushbutton.

Provides Nonplugging Protection

In *Fig.* 1, the counter-voltage relay CV provides this nonplugging protection. This relay picks up on line voltage when the main switches close, and holds in on counter voltage until the motor reaches a low speed. Its contacts are used to interlock the coils of the directional contactors. When the resistor LM is in series with either set of coils, the contactors will not pick up. They will, however, hold in with this resistor in series, once they have closed. The resistor could be replaced by parallel interlocks on the directional switches but these would not be as trouble-free and, furthermore, might not be available. Therefore, an advantage lies in using the interlocking resistor. Either circuit requires that relay CV be dropped out before the directional contactors will pick up. It will be noted that relay CT also has contacts in this interlocking circuit. This is to insure that the armature timing relay is picked up and ready to function before the motor is connected to the line.

Another method of obtaining nonplugging protection is to provide lock-out magnets on the directional switches, with the coils of these magnets connected across the motor armature. The switches then cannot pick up as long as there is a counter voltage. The choice of scheme to be used depends upon what devices are available and whether or not they combine to furnish other necessary functions.

Field Failure: Loss of the field on a shunt direct-current motor will cause a heavy current inrush in the armature for reasons discussed under field acceleration and, if the load is light, the motor might speed up. There will always be some residual field to produce a torque, even with an open field circuit. This tendency to accelerate will, if there is little or no connected load, cause the motor to reach dangerous speeds and possibly fly apart before the overload disconnects it from the line. Thus, on many installations, additional protection is desirable.

The field loss or field failure relay, FL in *Fig.* 1, has its coil connected in series with the field. Its contacts are in the control circuit, so that, when the relay drops out upon loss of field, the motor is disconnected. Of course, the field-failure relay must have a coil which will carry the maximum field current without overheating. The actual operating point, however, is based upon the minimum field current, because the relay must not drop out when the motor is running at its maximum rated speed. A practical relay for this use should have a ratio of maximum current to drop-out current of at least 10:1 to be suitable for most 4:1 motors. Where the field-current range is not as wide as that available in the relay, the drop-out setting can be raised. This value should be kept as high as practicable in order to afford maximum protection.

The resistance of the field-failure relay coil must be no more than about ten per cent of the field resistance, so that the voltage on the field is not reduced appreciably by the introduction of the relay. In the case of small motors having low-wattage fields, this may place a serious limitation on the watts available for operating the relay and, obviously, will have to be taken into account when a coil is selected.

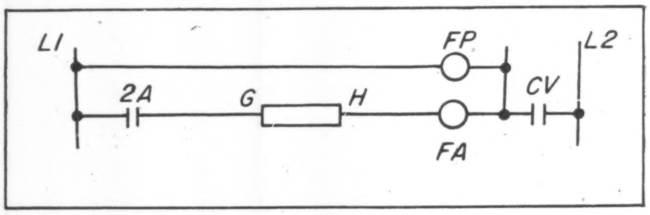


Fig. 8—Alternate connections for FP and FA relays

When considering the setting of a field-failure relay, certain factors having to do with the circuit must be taken into account. First of all, is the field rheostat in or out of the circuit at the time the start pushbutton is operated? If it is shorted out, there will be no question about the relay being picked up, and its contacts can be placed directly in series with the main switches. Here the setting will be a drop-out value of 65 per cent of the minimum field current (to allow for low voltage).

If the rheostat could be entirely inserted so that minimum current might exist at the time of starting, then the relay must be set to pick-up rather than drop-out on 65 per cent of minimum field current. The drop-out value should be as close to the pick-up as relay design permits. A practical ratio is 1:2.

When the range of the field current is so wide that a pick-up setting of 65 per cent minimum current cannot be obtained but it is possible to set the drop-out at that value, the only problem is one of closing the relay or bypassing its contact so that the motor can be started. The control will then automatically apply full field for starting and the relay will pick-up if it has not already done so. The desired function can be accomplished either by requiring that the operator turn the rheostat, if necessary, to provide greater field current or by relocating the relay contacts so that they are in the maintaining circuit only.

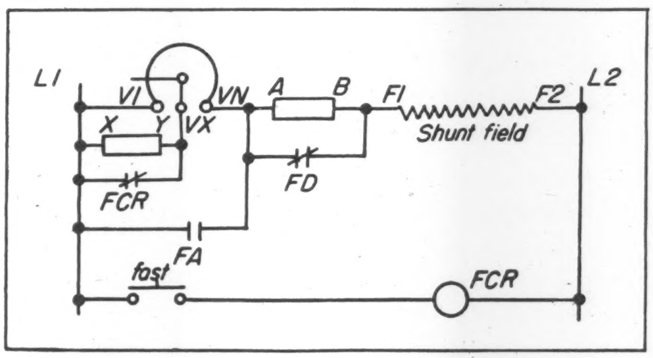
The foregoing discussion assumes that the field is not disconnected by the motor, although it would, of course, be behind the main line disconnect switch. In nonreversing starters, without dynamic braking, the field is often placed behind the main contactor, thus being disconnected with the motor armature. If a field-failure relay is applied to such a controller its contacts must be placed in the maintaining circuit because the field is dead at the instant of starting.

In the case of motors having wide speed ranges, the application of a single field-failure relay is often impossible under any consideration. One answer to this is to use two relays as shown in *Fig.* 5. The setting on 1FL is based upon minimum field current as described. The purpose of 2FL is to protect the coil of 1FL on the higher field currents, and its coil, therefore, must be designed to carry the maximum field current. After 2FL picks up, a portion of the current is shunted around the coil of 1FL.

On compound motors, having a series field as well as a shunt field, a compound field-failure relay is often necessary. Inrush currents in the series field during starting may cause the shunt field current to drop materially, or even reverse, due to the inductive coupling between the two fields. A single-coil field-failure relay would, of course, drop out during this transient condition. In the compound relay, a series-field coil adds to the usual shunt-field coil during starting. The circuit is shown in *Fig.* 6. The additional coil FL 2 is placed in series with the starting resistor and thus is shorted out when the last accelerator closes.

Another type of field-failure relay is sometimes used to protect against grounds in the field, which could reduce the field strength to a dangerous value and still not cause the usual series relay to drop out. This device must, however, be used in combination with the series relay because it would not protect against open fields. It is known as a differential field failure relay (2FL in *Fig.* 7) and has two shunt coils connected from a center tap in the field to each side. Normally the two coils produce an equal and opposite effect on the relay so that it does not pick-up. Should a ground occur, there would be an unbalance between the two coils and the relay would function to open the control circuit.

Fig. 9—High speed operation by hold-down pushbutton



Field Protection: Frequently, it is desirable that the field be connected to the line at all times so that the motor will stay warm and dry. Furthermore, on reversing circuits or where dynamic braking requires a field after the motor is disconnected, removing the field from the line involves extra control devices. For the above reasons, most standard controllers leave the field connected to the line after the motor is stopped.

With the rotor at standstill there is no windage to carry heat away from the stator and, on some motors, the field will not stand full voltage without overheating. In these cases, a field-protective relay (FP in *Fig.* 1) is added for the purpose of reducing the field wattage. The coil of this relay is shown energized by interlocks on the directional switches. In this way, the protective resistor BC is shorted when the motor is running. It is common practice to cut the field watts approximately in half with the field protecting resistor. If the resistor is selected to be equal to one-half the field ohms, the current will be cut to two-thirds and the watts to four-ninths. This is an acceptable basis for design.

Incorporates Dynamic Braking

The circuit in *Fig.* 1 includes dynamic braking. For this reason full field is desirable during stopping to obtain the maximum braking effect. At the time of stopping relay FA will be closed by the shunt coil FA 2, thus shorting the rheostat. Although FP opens at the same time, and inserts the protecting resistor, this can usually be considered to have a negligible effect on the braking. Reduction of the field current by one-third actually reduces the field strength by much less than that amount due to saturation in the iron.

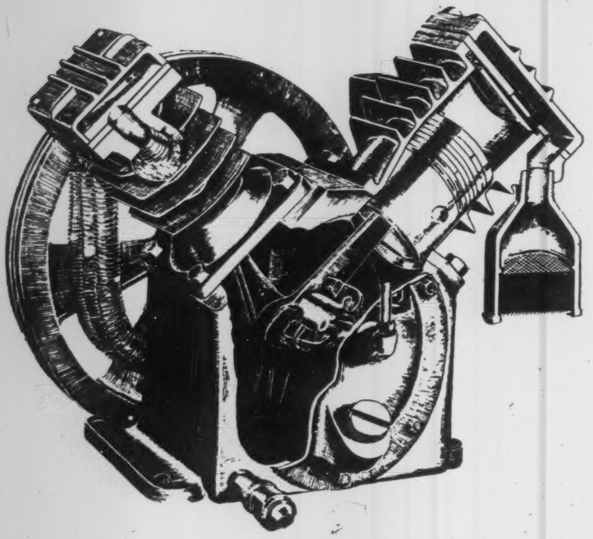
Another connection for the FA and FP relay coils is shown in *Fig.* 8 where, by means of another contact on relay CV, maximum field is maintained during stopping. When the motor reaches a low speed, relay CV drops out, and inserts not only the field protecting resistor but also the field rheostat, which, incidentally, might be set for little or no resistance. With this connection for the shunt coil of relay FA, however, field protection is provided if the operator turns up the rheostat after the motor stops. No separate FP relay would then be required.

Jogging Relay: Up to this point only what might be considered protective relays have been discussed. Of the relays used to obtain special operating features, the most common is the jogging relay. It is used to obtain jogging operation of the motor from a separate pushbutton. The function of the relay is to provide a maintained circuit for normal running but to interrupt this circuit for jogging.

Relay JR in *Fig.* 1 gives the desired operation. For comparison, it is shown in the reverse circuit only. The "jog-reverse" pushbutton energizes the reverse switches but, since the maintained circuit is open, these switches will drop out when the pushbutton is released. The "reverse" pushbutton picks up the JR relay as well, and its contacts maintain the circuit. The necessary changes to give jog forward with the same relay will be evident at once.

Jogging can be done under different speed conditions, depending upon the requirements of the application. Sometimes the series armature resistor and dynamic brak-

(*Continued on Page* 182)



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Designing for Pneumatics

Part III—Power Uses

PRECEDING articles in this series have covered briefly the equipment in a compressed air system up to the point of use. The following sections will deal with the two major applications of compressed air, i.e., power uses of air and control uses of air. The distinction between these two applications is not definite as both require power *and* control but emphasis is usually placed on one or the other.

To obtain mechanical energy from the pneumatic pressure energy of compressed air there are two recourses:

1. The compressed air can be applied behind a piston, blade, tooth, vane or even a fluid in a closed cylinder. Because of the pressure differential across the piston or other moving element, force is applied to it. When the piston is allowed to move against a load, work is accomplished,

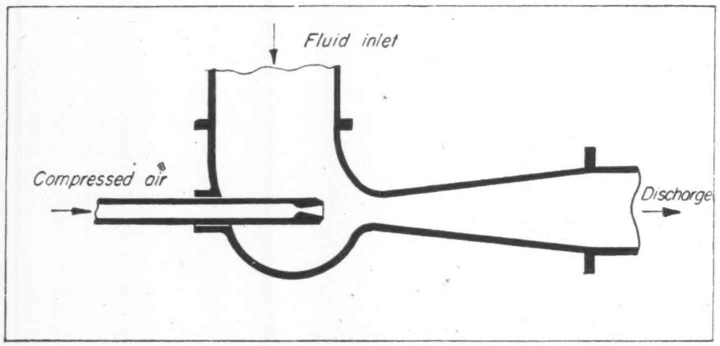
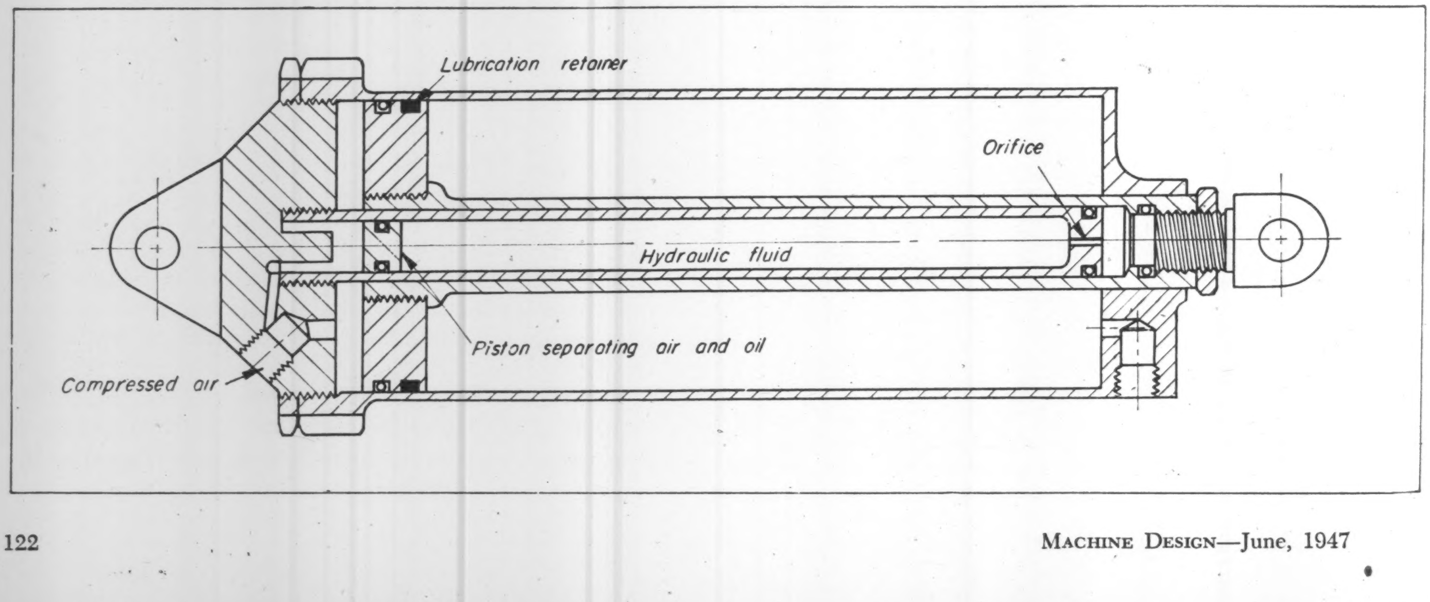

Fluid inlet
Compressed air
Discharge

Fig. 20—Above—Salient features of the air-jet ejector pump which converts velocity into pressure energy

Fig. 21—Below—Pneumatic cylinder with integral hydraulic damping provided by a special design of piston rod


Lubrication retainer
Orifice
Hydraulic fluid
Piston separating air and oil
Compressed air

which may be linear, rotary, etc., in nature

2. The compressed air may be allowed to expand in a nozzle converting most of the pressure energy into kinetic energy in a high-velocity air stream. This stream may be made to impinge on an impulse type turbine blade which, in turning the direction of the stream of air, converts the kinetic energy to mechanical energy. Or, the nozzle may be installed on the turbine wheel and a reaction obtained at the rim of the wheel by the increase in velocity in the nozzle-bucket. To be efficient these turbines require high bucket velocities (1000 to 1500 fps frequently is desirable) which generally means high rotative speeds. This may be advantageous.

To obtain pressure energy in another fluid, the air may be applied directly to it in a closed vessel or it may be applied through a direct-acting piston pump with one piston operating on air and the other on the fluid. Again, it may be expanded into a high velocity airstream and directed into the fluid as shown in *Fig.* 20. This air-jet ejector pump first picks up the fluid or gas and accelerates it to a high velocity (but not as high as the incoming air stream). Thus velocity is converted to pressure energy in the diffuser section of the ejector.

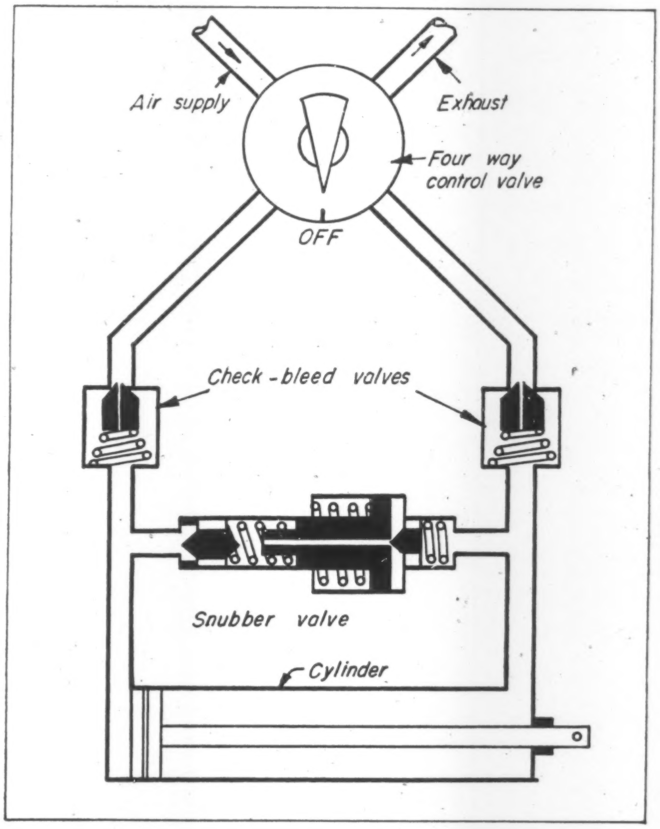


Fig. 22—Above—Schematic of control for air cylinder with valve to insert air charge in one direction. Movement of cylinder is to the right

Fig. 23—Below—Valve used to insert air charge cushion into an air cylinder before operation, as shown in Fig. 22. This ¼-inch size valve is suitable for a 5-inch bore cylinder with a 24-inch stroke operating at 500-psi pressure

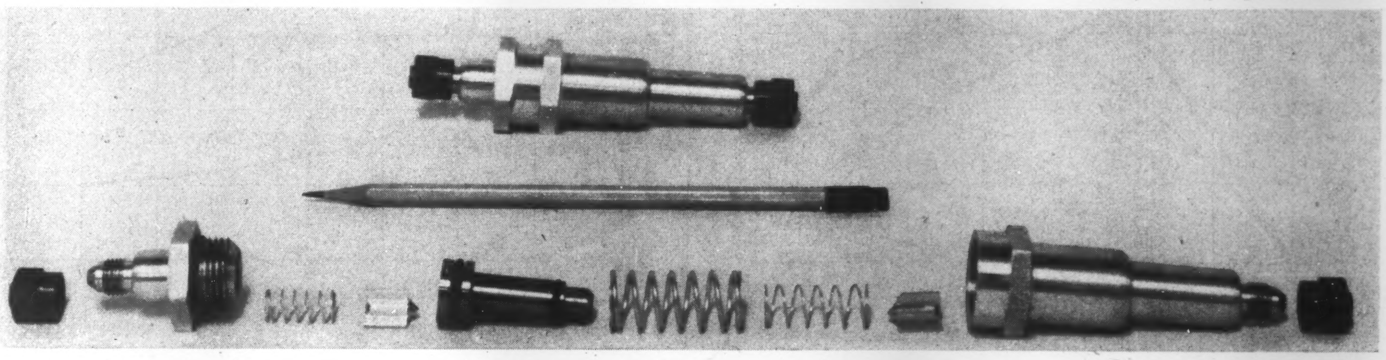
Definite Control of Cylinders Desirable

Pneumatic cylinders for linear motion differ from hydraulic cylinders only in the way they are lubricated and cushioned. Since the air is a compressible fluid, it is necessary at times to provide a definite control over the movement of the piston throughout its stroke, especially where a high initial load falls to a low or negative value near the end of the stroke. Control over the stroke of the piston can be accomplished in several ways:

1. Mechanical control over the stroke, regardless of the pressure existing behind the piston, as in the standard piston type air motor where the speed of the piston is entirely a function of rotative speed and crank angle
2. Piston loading arranged so that the largest force requirement occurs at the end of the stroke. In this case the speed of the piston is a function of the air admission rate
3. Hydraulic snubbing or metering control so that the speed of operation is not a function of the load alone but also of the force required to flow oil through a metering orifice. A cylinder with hydraulic damping is shown in Fig. 21
4. Mechanical friction snubbing control, specifically used or inherent in the load
5. Pneumatic snubbing control. This requires the control of the air from the downstream side of the piston so that the pressure retarding the piston increases rapidly when the load falls off and piston speed increases, Fig. 22. By controlling the rate of airflow *from* the cylinder as well as compressed air to the cylinder, almost any type of load can be handled with controlled piston movement.

Most conventional applications of air cylinders have air pressure applied to one side of the piston or the other at all times. It is a simple matter, therefore, to bleed the exit compressed air in the cylinder through a metering valve to exhaust from one side of the piston while compressed air is being metered into the other side. However, in some cylinders all air is drained from the cylinder after movement has occurred leaving only one atmosphere

Photo, courtesy Ingersoll-Rand Co.



of air in the cylinder to compress and meter out. Many times this is inadequate so a charge of air must be applied to the wrong side of the piston for cushioning before it is applied to the correct side of the piston for travel. One commercially available type of valve to insert this cushion charge is shown in *Fig.* 23.

Pneumatic Motors: There have been so many different pneumatic motors built in the last fifty years that it is impossible to consider them all; however, Table I attempts to give a few brief comments about the types that have withstood the tests of time. Some explanation of these comments may be helpful in evaluating the various air motors. Positive starting means that full torque is available *every* time full air pressure is applied. A balanced rotor is one that is inherently balance. Most of the rotors can be balanced by adding counterweights or similar means. Lubricated machines require oil in the air to lubricate sliding vanes or rubbing surfaces that cannot be oiled any other simple way. Of course all units require a satisfactory type of lubricant for the bearings and reduction gears.

To make possible a general comparison of the more common types of rotary air motors, as listed in Table I, typical performance charts are shown in *Figs.* 24, 25 and 26 for a small radial, nonreversible, piston type air motor, a small, sliding-vane type, and a small impulse type air turbine.

Efficiency Increased with Hot Air

The overall efficiency of any of these motors can be increased or the air consumption can be reduced by using the air as hot as possible. Generally heating of the air can only be justified in applications where considerable power is used more or less continuously and where the air motor is suitable for hot operation. For example, the air consumption of a pneumatic motor of the reciprocating piston type is reduced 20 per cent by increasing the inlet air temperature from 70 F to 200 F. Running on hot air also reduces the possibilities of water freezing troubles at the exhaust (due to the expansion of the air) and increases the mechanical efficiency slightly.

In order to show the many types of service where compressed air is or may be used, the following general list-

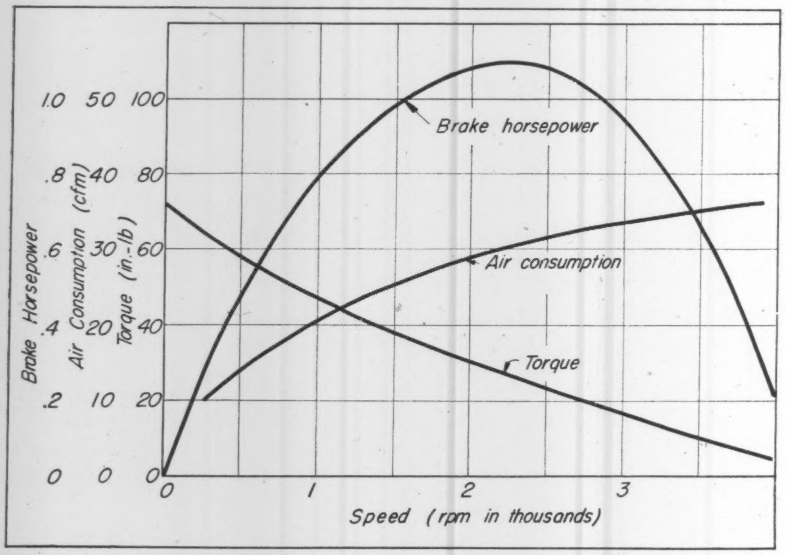


Fig. 24—Left—Typical performance characteristics of a small radial, nonreversible, piston type air motor

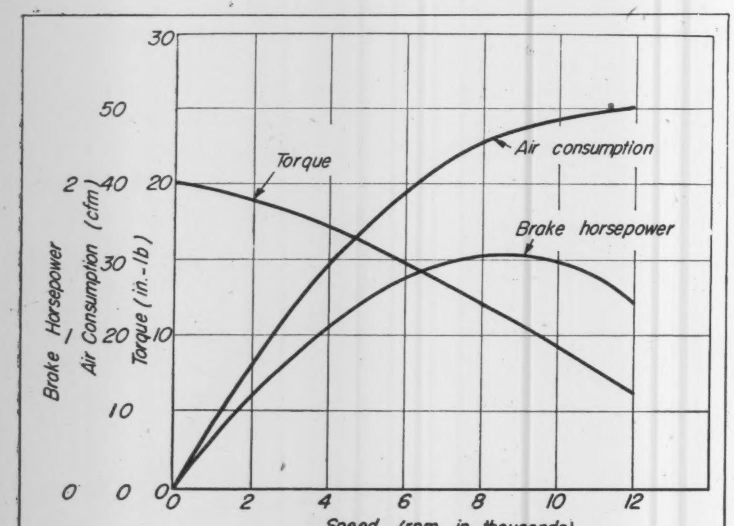


Fig. 25—Left Below—Typical performance characteristics of a small, sliding-vane air motor

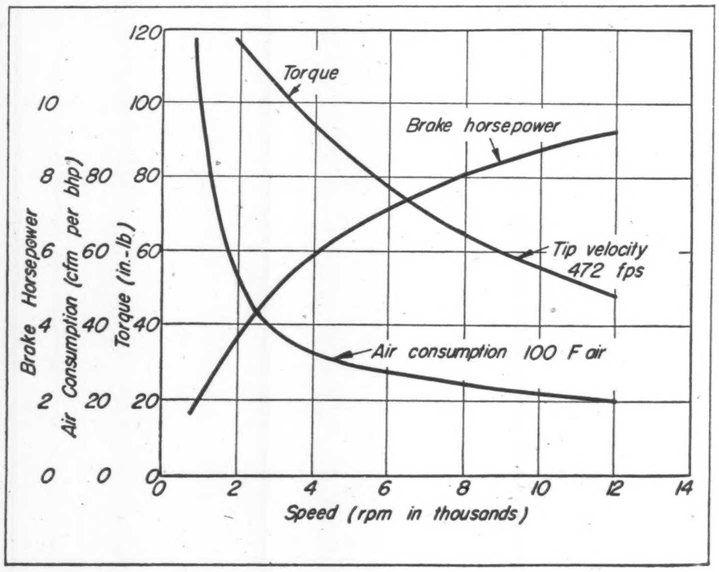
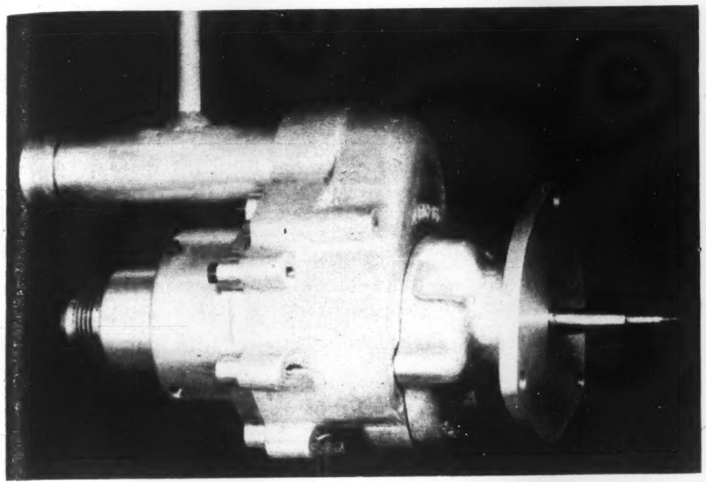
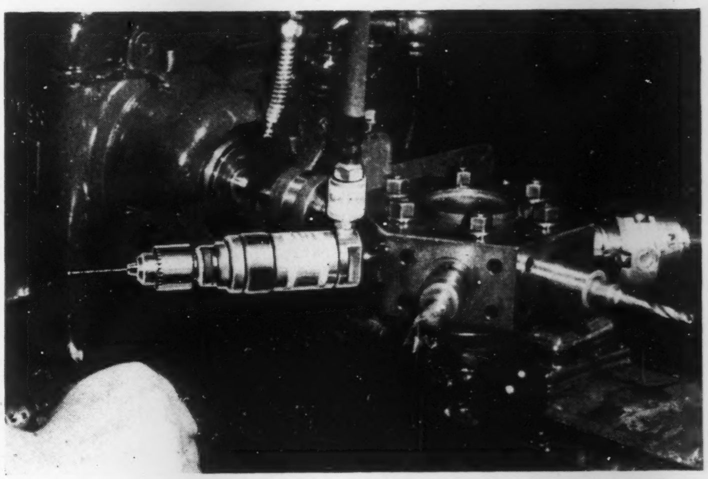


Fig. 26—Below—Typical performance characteristics of a small, impulse type air turbine



Photo, courtesy Harvey Machine Co.

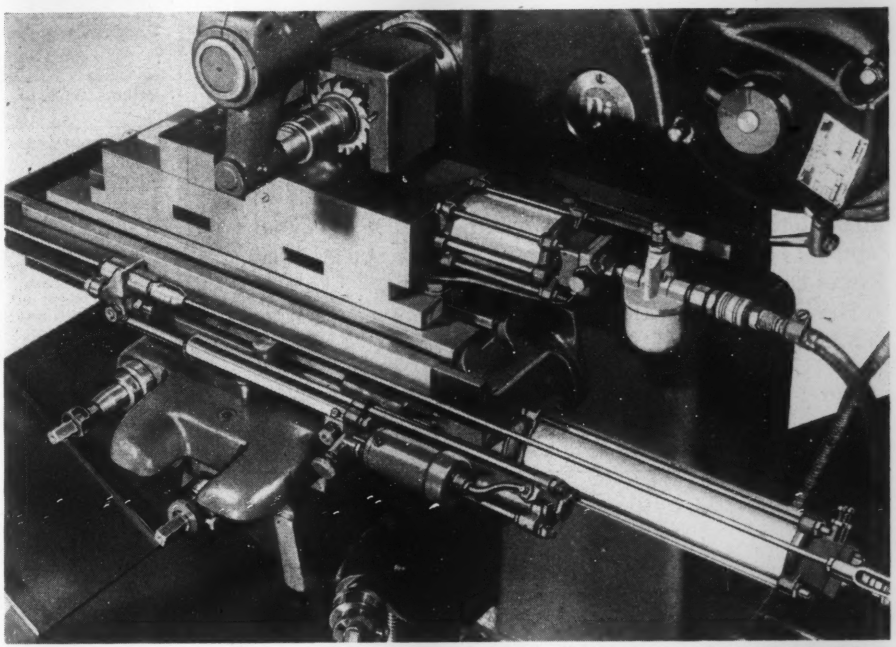


Photo, courtesy Aro Equipment Corp.

Fig. 27—Above — Small pneumatic turbine designed for submerged operation. Unit uses 45-psi air, delivers over 3 hp, weighs only 4 pounds, and the turbine wheel which is geared to output shaft runs over 50,000 rpm

Fig. 28—Above Right—Small, high-speed drill driven by a 100-psi vane type air motor mounted on a turret lathe to speed drilling operation

Fig. 29—Right—Small bench miller designed for mass production has table movement powered by a hydraulically controlled air cylinder



Photo, courtesy W. H. Nichols & Sons

ing of typical applications, which is by no means complete, is given:

1. **Free piston machines**
   - Riveting hammers
   - Rock drills (hammer type)
   - Pavement breakers
   - Chisels
   - Sand and earth tampers
2. **Air motors and turbines**
   - Pumps for explosive atmosphere, submersible drives, *Fig.* 27, or drives where only air power is available
   - Hand-held and machine power tools—drills and grinders up to 100,000 rpm, *Fig.* 28, wrenches—conventional or impact type, screwdrivers, sanders and buffers
   - Paint mixers (inflammable atmosphere)
   - Aircraft service—landing gear and wing flap actuation typical engine and gas turbine starting
   - Hoists, drum type—reciprocating, gear and vane motors
3. **Linear Motors** (cylinders)
   - Vises
   - Hoists
   - Movements on machine tools, *Fig.* 29
   - Door operation
   - Aircraft—landing gear operation typical
   - Forge hammers
4. **Pneumatic displacement**
   - Reciprocating—direct acting, pumps
   - Ballast blowing (marine)
   - Air lift pumps
   - Tunnel pressurization
   - Holding plastic materials while setting
   - Air injection engine starting
   - Agitation of liquids
5. **Other applications**
   - Air inductor—small amount of high-pressure air used to move large amount of low-pressure air
   - Heating or cooling with compressed air
   - Sand blasting
   - Shot peening

There are several power uses of compressed air that deserve further explanation because they may have other applications. One of these is the air lift pump, *Fig.* 30. This pump is not only extremely simple and reliable but can handle any liquid, especially corrosive or gritty liquids, as no moving parts are in contact with the fluid being pumped. As shown in *Fig.* 30, the column of liquid and air mixture in the discharge pipe has a lower mean density, because of the air bubbles rising in the liquid, than the solid column of liquid in the tank or well. At the footpiece or entrance to the discharge pipe the pressure from both columns must be equal, hence the less dense column must be longer. By arranging the heights, air pressure and flow of air upward through the water column in the discharge pipe, pumping occurs.

Air pressure required is a function of the submergence and the liquid density:

$$P=A\rho/144 \qquad (12)$$

where P is the air pressure at the footpiece in psi; A is the submergence in feet, *Fig.* 30; and ρ is the liquid density in pounds per cu ft.

Expressed as a percentage of the discharge pipe length, the submergence is used in calculating the compressed air required:

$$\text{Percent Submergence}=100\ A/B \qquad (13)$$

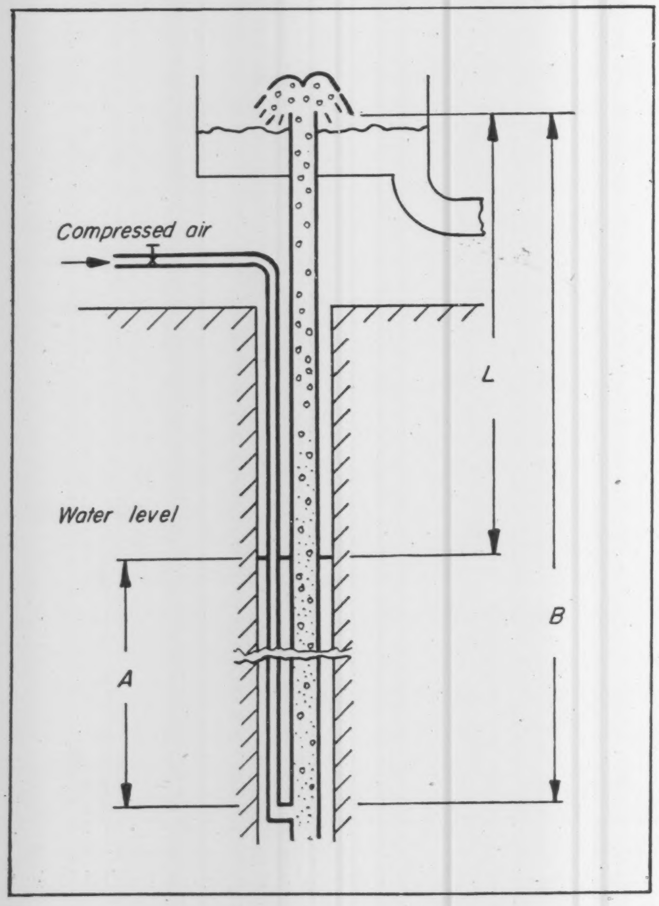
where B is the discharge pipe length, *Fig.* 30. For acceptable efficiency the submergence must be not less than 35 per cent, and 70 per cent is desirable.

The following equation gives the air requirements when pumping water:

$$V_a=\frac{L}{C\log_{10}\dfrac{A+34}{34}} \qquad (14)$$

where V_a is the number of cubic feet of free air required per gallon of water pumped; L is the total lift in feet; A is the submergence in feet; and C is a constant which can be found from the chart in *Fig.* 31.

Fig. 30—Schematic diagram of an air-lift pumping system



This equation applies when using a discharge pipe of constant diameter. Actually the air bubbles increase in size as the liquid and air rise to the surface, where the pressure is reduced. Therefore, a tapered discharge pipe should be used to maintain uniform velocity. The overall efficiency of an air lift pump is generally too low to compete with present centrifugal and deep-well turbine type pumps, but they find many applications where efficiency is secondary.

TABLE I—Common Types of Pneumatic Motors

Motors for Linear Motion	
Piston types	Simple and reliable where applicable, must be self or non-lubricated, may leak, poor efficiency, no expansion
Diaphragm types	Good for short stroke, low pressure, nonleaking, no lubricant needed, large diameter, poor efficiency
Bellows types	Short stroke, medium pressures, nonleaking, small diameter, poor efficiency
Free piston types	Simple but applicable to special loads only as percussion tools, not positive starting, fair efficiency
Motors for Rotary Motion	
Reciprocating—piston motors — cylinder arrangement may be radial, in-line, Vee, barrel, inside out, opposed, with any type of crank or cam mechanism	Good starting torque, heavy and bulky for output, low speed, limited expansion, can stall without damage, low cost, easily serviced, must be lubricated, difficult to balance
Rotary sliding-vane motors — may be multivane, single through vane, Velox type vanes	Some designs not positive starting, fair starting torque, small and fairly lightweight for output, medium speed, limited expansion, high leakage when stalled, requires little lubrication, high grade service required, balanced rotor
Stationary sliding-vane motors	Same comments as for rotary sliding vane. Generally leakage is slightly greater with this type and rotor is unbalanced
Lobe Type Motors—gears, two meshing gears encased	Simple, good starting torque, positive starting, medium speed, no expansion with straight spur gears, high leakage, poor efficiency, must be lubricated, easily serviced, balanced, medium weight and size for output
Lobe Type Motors—two meshing lobes encased	Requires synchronizing gears, good starting torque, positive starting, medium speed, no expansion, high leakage, poor efficiency, no lubrication of lobes required, balanced, heavy and bulky for output
Lysholm-Type Motors lobe, axial flow	Requires synchronizing gears, good starting torque, positive starting, medium speed, expansion, high leakage, fair efficiency, no lubrication of lobes required, balanced, heavy and bulky for output
Turbine Type Motors—impulse and reaction types, axial and radial inward flow	Poor starting torque, positive starting with full air supply, high speed, expansion, good efficiency when properly applied, only bearings need lubrication, balanced, very lightweight and small for power required, non reversible
Viscous - Drag Tesla type motor—radial inward flow	Same comments as for turbine type, except reversible

Another application that makes use of the advantages of compressed air is the impact wrench. These hand-held power-operated wrenches accumulate energy during most of the revolution and apply it in the form of an impact of extremely short duration. This enables one to apply high

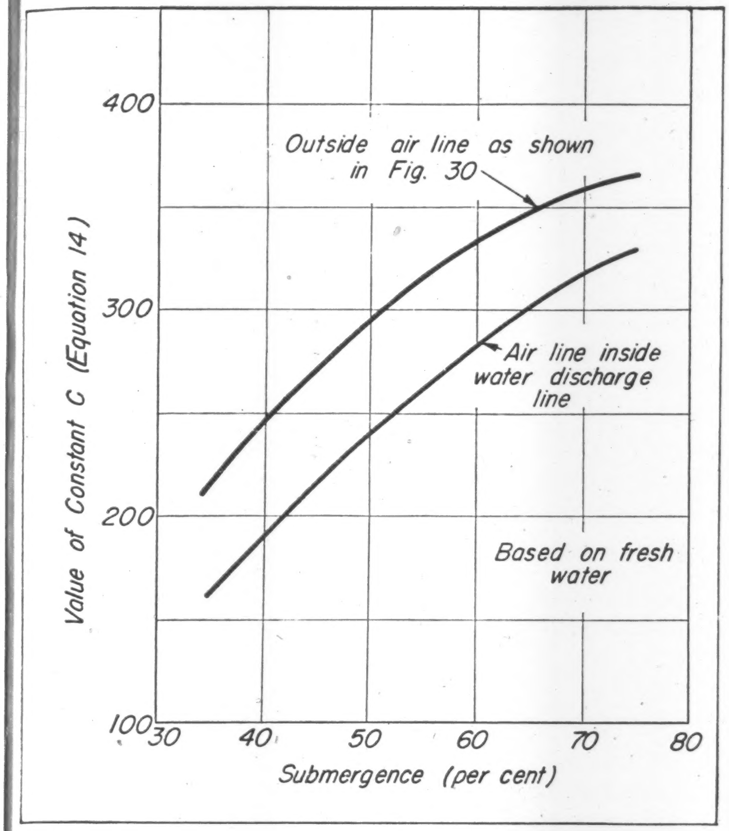


Fig. 31—Chart of constants to be used in calculation of air consumption of air-lift pumps such as shown in Fig. 30

torques (to a nut) with very little reaction on the handles of the tool. Most wrenches accumulate the energy from a pneumatic motor in compressing a spring. This is then converted to kinetic energy in a rotating mass which is stopped by a jaw clutch on the output shaft. One model, however, uses the rotor of the motor for the rotating mass. It is stopped each revolution when it strikes the anvil (jaw clutch) and then is rapidly accelerated by air pressure so that it is traveling at full speed at the end of a revolution when it strikes the anvil again. This particular design problem can be solved best with compressed air as a power source because of its low inertia effects.

The fourth part in this series of articles on pneumatics will appear in the July issue of Machine Design. This final part will cover in particular the control uses of compressed air, dealing with valves, snubbers, regulators, remote-position drives, pressurization control, etc.

Engineered Plastics

PROBABLY the bulk of all plastics usage is made up of assemblies which are constructed primarily of plastics, but which may embrace two or more different plastics and may well require other materials in order to result in a well-engineered assembly. A new textile bobbin is an example. In itself it is unique in the textile industry because it will handle eight pounds of yarn at 6,000 rpm.

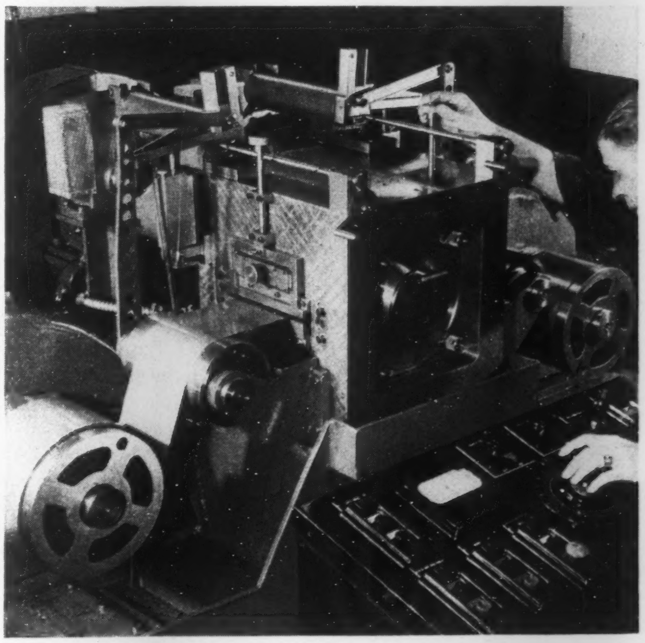
It has a molded-laminated base, a laminated tube for a portion of the barrel, a high-impact molded cone for the remainder of the barrel, the conical shape being for functional reasons, a separate impact-molded cap and flange, and an SAE-1015 seamless steel tube which serves to hold the assembly together. The bobbin is bored to precision fits at either end, these fits being held to a total tolerance of 0.001-inch—much closer than they could be held in any plastic. Finally, the whole assembly is dynamically balanced to 0.01-ounce-inch by the addition of lead slugs held in place by brass disks designed to anchor in the plastic when inserted in the balancing holes and flattened out. Six different materials are used, but with primary emphasis on plastics. This type of thing is not plastics engineering but rather engineered plastics.—*From a paper by R. L. Foote, Synthane Corp., presented at a recent SPE meeting in Chicago.*

Mill Rolls Tissue-Thin Strip

MINIATURE Sendzimir precision cold strip mill now rolling Hiperco alloy for experimental use at the Westinghouse Research Laboratories, below, stands less than the height of a man and is about as wide as an office desk. Each part of the delicately balanced roll mechanism is ground to within 0.0001-inch to assure precision rolling of metal to 0.002-inch strip thickness.

Designed by the Armzen Co., the mill employs two rolls which measure less than half an inch in diameter and produce forty times more compression than larger rolls of commercial units. In operation, a 100-foot length of 0.025-inch metal is fed into the mill and wound on 12-inch reels located at either end of the rolling mechanism. Pulled back and forth at speeds up to 200 feet per minute, seven complete passes produce strip 0.002-inch in thickness about a mile long. Proper tension on the strip during rolling is maintained by a Rototrol regulator.

Hiperco, product of the mill, is a new magnetic alloy that gives promise of aircraft motors and generators as much as 10 per cent lighter in weight than those now available.



Locking

An analysis of self-locking fasteners now available for use in machine elements

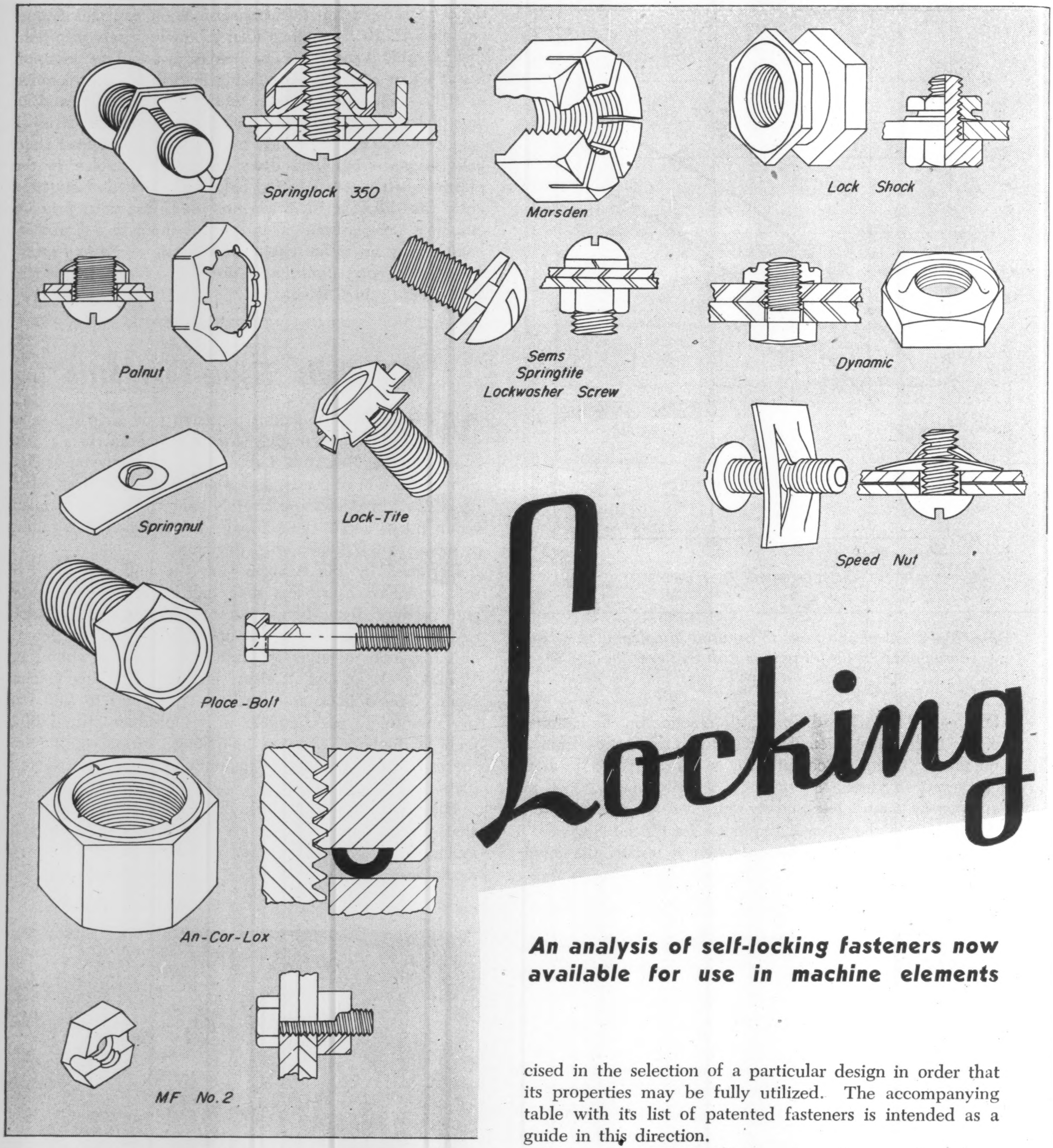


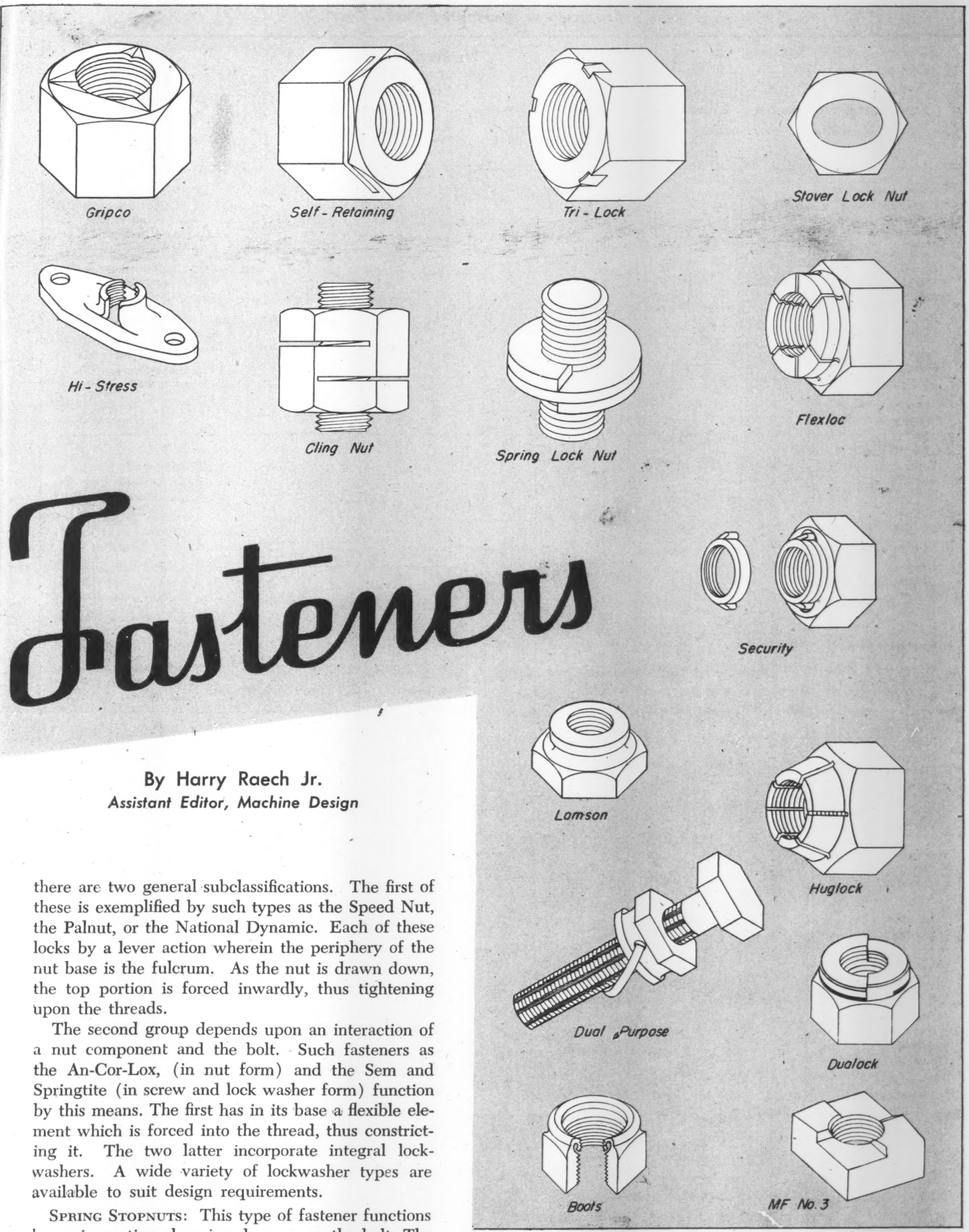
Fig. 1—SEATING-LOCK FASTENERS: Interaction between seat and bolt securely tightens nut. This type locks only when seated firmly against its plate

LOCKING fasteners in over fifty different types are currently available for selection by the designer. Since each of these types has special features which will make it of particular value in the solution of a given machine problem, it is important that great care be exercised in the selection of a particular design in order that its properties may be fully utilized. The accompanying table with its list of patented fasteners is intended as a guide in this direction.

For purposes of classification, these fasteners have been divided into six groups: Seating lock, spring stopnut, interference, wedge, blind and quick-release. The method of locking is the key to the name of each of the groups save the last, which is identified by its function.

Seating Lock: This largest group, *Fig.* 1, locks only when firmly seated and is therefore free-running on the bolt. Perhaps its most outstanding feature is the fact that the locking force increases with the amount of tightening given the fastener. While all of these fasteners lock by interaction between the seat and the bolt, through the nut,

Fasteners


Gripco
Self-Retaining
Tri-Lock
Stover Lock Nut
Hi-Stress
Cling Nut
Spring Lock Nut
Flexloc
Security
Lomson
Huglock
Dual Purpose
Dualock
Boots
MF No. 3

By Harry Raech Jr.
Assistant Editor, Machine Design

there are two general subclassifications. The first of these is exemplified by such types as the Speed Nut, the Palnut, or the National Dynamic. Each of these locks by a lever action wherein the periphery of the nut base is the fulcrum. As the nut is drawn down, the top portion is forced inwardly, thus tightening upon the threads.

The second group depends upon an interaction of a nut component and the bolt. Such fasteners as the An-Cor-Lox, (in nut form) and the Sem and Springtite (in screw and lock washer form) function by this means. The first has in its base a flexible element which is forced into the thread, thus constricting it. The two latter incorporate integral lockwashers. A wide variety of lockwasher types are available to suit design requirements.

Spring Stopnuts: This type of fastener functions by spring action clamping down upon the bolt. The type is thus useful as a positioning nut as well as a securing fastener. Several methods of achieving this action are shown in the illustration, *Fig.* 2. Types

Fig. 2—SPRING STOPNUTS: Spring action of nut squeezes bolt at all times. Nut will therefore retain position at any point on the bolt despite considerable vibration

Properties of Locking Fasteners

Type and Tradename	Re-usable	Spring Effect	Assembly Speed		Mechanical Strength Compared with Standard Machine Screws				Originating Manufacturer or Licenser*
			Fast	Moder-ate	High Shear	Low Shear	High Tens.	Low Tens.	
Seating Lock									
An-Cor-Lox	X			X	X		X		Laminated Shim Co.
Dynamic	X			X	X			X	Nat'l Screw & Mfg. Co.
L'kwasher Screw	X			X	X		X		Lamson & Sessions Co. (1)
Lock Shock	X			X	X		X		Costello Lock & Torque Nut Co.
Lock-Tite	X			X	X		X		Continental Screw Co.
Marsden	X			X	X		X		American Marsden Co. (2)
MF No. 2	X			X	X			X	MacLean-Fogg Lock Nut Co.
Palnut	X			X		X		X	The Palnut Co.
Place-Bolt	X			X	X		X		Place Capscrew & Bolt Co. (3)
Sems	X			X	X		X		Shakeproof, Inc. (1)
Speed Nut	X	X	X†	X		X		X	Tinnerman Products Co. (4)
Springtite	X			X	X		X		Eaton Mfg. Co., Reliance Div. (1)
Springlock 350	X			X		X		X	Prestole Corp.
Springnut	X	X	X†	X		X		X	Prestole Corp.
Spring Stopnut									
Boots	X			X	X		X		Boots Aircraft Nut Corp.
Cling Nut	X			X	X		X		Beach Precision Parts Co.
Dualock	X			X	X		X		Dualock Products
Dual Purpose	X			X	X		X		Simmons Fastener Corp.
Flexlock	X			X	X		X		Standard Pressed Steel Co. (5)
Gripco	X			X	X		X		Grip Nut Corp.
Hi-Stress	X			X	X		X		Tinnerman Products Co.
Huglock	X			X	X		X		Nat'l Machine Products Co. (6)
Lamson	X			X	X		X		Lamson & Sessions Co.
MF No. 3	X			X	X		X		MacLean-Fogg Lock Nut Co.
Security	X			X	X		X		Security Locknut Corp.
Spring Locknut	X			X	X		X		Geo. K. Garrett Co. Inc.
Stover Lock Nut	X			X	X		X		Stover Locknut & Mach.
Self-Retaining	X			X	X		X		Columbia Nut & Bolt Co.
Tri-Lock	X			X	X		X		Boots Aircraft Nut Corp.
Interference									
Esna	X			X	X		X		Elastic Stop Nut Corp.
Hi Shear				X	X			X	Nat'l Screw & Mfg. Co.
Lockbolt				X	X		X		Huck Mfg Co.
Lok-Thred	X			X	X		X		Lock Thread Corp. (7)
Nylok	X			X	X		X		Nylok Corp.
Pem	X			X	X		X		Penn Eng. & Mfg. Corp.
Wedge									
Anco	X			X	X		X		Automatic Nut Co.
Columbia	X			X	X		X		Columbia Nut & Bolt Co. (8)
Drake	X			X	X		X		Nat'l Screw & Mfg. Co.
Klincher				X	X		X		Faultless Caster Co.
Dardelet	X			X	X		X		Lock-Thread Corp. (9)
Blind									
Cherry				X	X		X		Cherry Rivet Co.
Dot Trimount†	X	X	X			X		X	United Carr Fastener Corp.
Explosive			X		X		X		E. I. DuPont
Huck				X	X			X	Huck Mfg. Co. (10)
Rivnut				X		X	X		B. F. Goodrich Co.
Scrivets				X	X		X		Nat'l Screw & Mfg. Co.
Snap-Clip†	X	X	X			X		X	Cuyahoga Spring Co.
Speed Nut C6638	X	X		X		X		X	Tinnerman Products Co.
Quick Release									
Airloc	X	X	X		X		X		United-Carr Fastener Corp.
Camloc	X	X	X		X			X	Camloc Fastener Corp.
Dzus	X	X	X		X			X	Dzus Fastener Co.
Lion	X	X	X		X		X		Lion Fastener, Inc.
Q-1	X	X	X		X			X	Shakeproof, Inc.
Q-2	X	X	X		X			X	Shakeproof, Inc.
Quicklock	X	X	X			X		X	Simmons Fastener Corp.
Springlock	X	X	X		X			X	Simmons Fastener Corp.

†Push-on Types.

*Numbers in parentheses refer to list of manufacturing licensees on facing page.

Licensed Manufacturers of Locking Fasteners

1. **Sems Licensees of Illinois Tool Works**
    - American Screw Co.
    - Butcher and Hart
    - Central Screw Co.
    - Chandler Products Corp.
    - Continental Screw Co.
    - Corbin Screw Div.
    - Eaton Mfg. Co., Reliance Div.
    - Lamson and Sessions Co.
    - National Lock Co.
    - National Screw and Mfg. Co.
    - New England Screw Co.
    - Pheoll Mfg. Co.
    - Progressive Mfg. Co.
    - Russell, Burdsall and Ward Bolt & Nut Co.
    - Scovill Mfg. Co.
    - Shakeproof, Inc.
    - Steel Co. of Canada, Ltd.
    - Stronghold Screw Products, Inc.
2. **Marsden Licensees of American Marsden Co.**
    - Automatic Products Co.
    - Federal Screw Works
    - Lamson and Sessions Co.
    - National Machine Products Co.
    - National Screw and Mfg. Co.
    - Russell, Burdsall and Ward Bolt & Nut Co.
    - Wood and Spencer Co.
3. **Place Bolt Licensees of Place Capscrew & Bolt Co.**
    - Buffalo Bolt Co.
    - Chandler Products Corp.
    - Chicago Screw Co.
    - Columbus Bolt Works
    - Federal Screw Works
    - Gary Screw and Bolt Co.
    - Lamson and Sessions Co.
    - National Machine Products Co.
    - National Screw and Mfg. Co.
    - Pittsburgh Screw and Bolt Corp.
    - Western Automatic Screw Co.
4. **Licensee of Tinnerman Products Co.**
    - Shakeproof, Inc.
5. **Flexlock Licensee of Standard Pressed Steel Co.**
    - Nutt-Shel Co.
6. **Huglock Licensees of National Machine Products Co.**
    - National Screw and Mfg. Co.
    - Russell, Burdsall and Ward Bolt & Nut Co.
7. **Lok-Thred Licensees of Lock Thread Corp.**
    - Chandler Products Corp.
    - Lamson and Sessions Co.
    - National Screw and Mfg. Co.
8. **Columbia Licensee of Columbia Nut & Bolt Co.**
    - Brightman Nut and Mfg. Co.
9. **Dardelet Licensees of Lock Thread Corp.**
    - American Hardware Corp.
    - John Bath and Co.
    - Bethlehem Steel Co.
    - Independent Pneumatic Tool Co.
    - Lamson and Sessions Co.
    - Landis Machine Co.
    - Geo. W. Moore, Inc.
    - Wm. H. Ottemiller, Co.
    - Pawtucket Mfg. Co.
    - Rockford Screw Products Co.
    - Speakman Co.
10. **Licensee of Huck Mfg. Co.**
    - Clark Equipment Co.

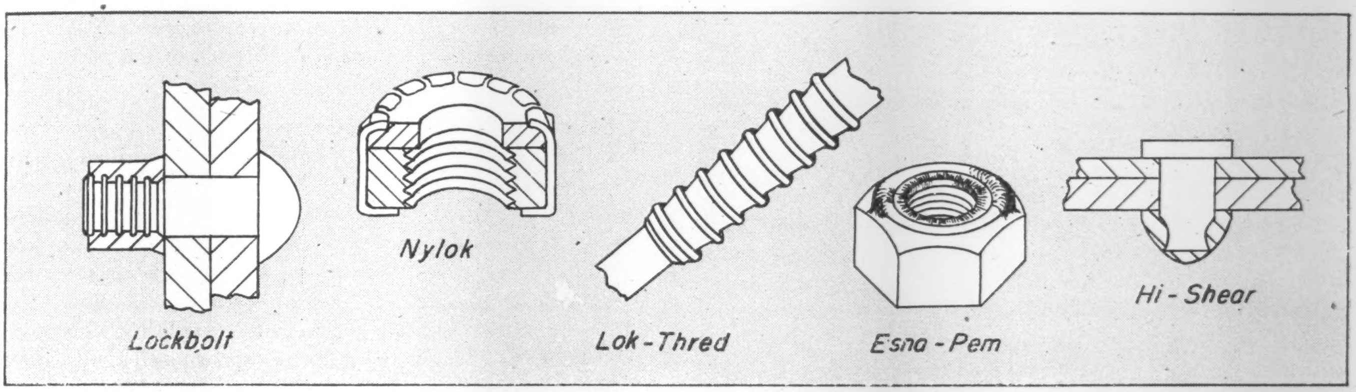
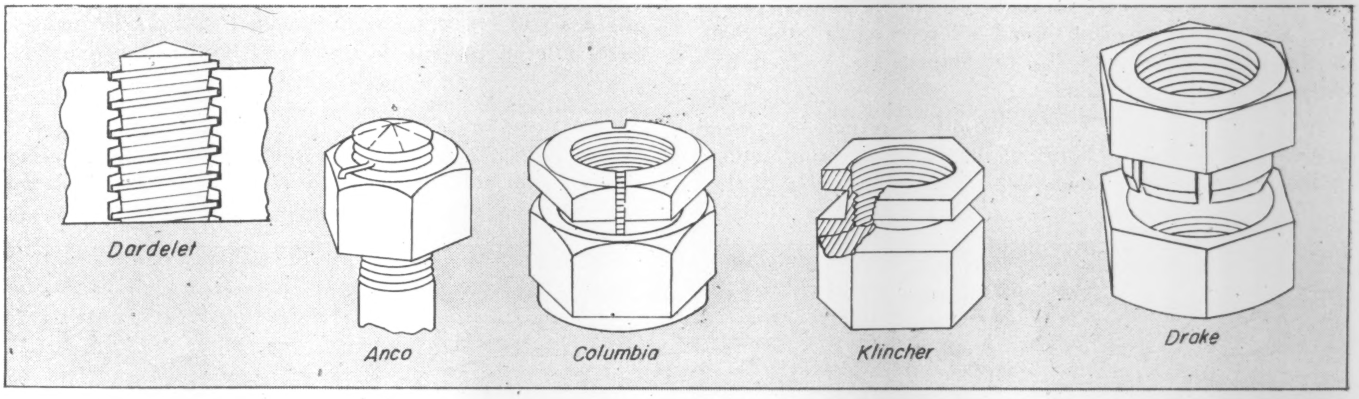


Fig. 3—Above—INTERFERENCE FASTENERS: Functioning is by a plastic flow of portion of fastener. Some members of this group can be used successfully as spring stopnuts

Fig. 4—Below—WEDGE-LOCKING FASTENERS: Relative wedging of two elements, nut and bolt, or two portions of nut, locks this type of self-locking nut



like Huglock have spring fingers machined into the upper portion of the nut. These grip the bolt by pressing inwardly. A second type, illustrated by the Stover Lock Nut functions because of the elliptical shape of the nut. This type, actually an elliptical spring, also presses inwardly upon the bolt. The third method of gripping is achieved by an interaction of elements of the nut. Boots and Self-Retaining are of this type. In these instances one threaded element of the nut is sprung slightly out of position with relation to another. The bolt is thus gripped axially at all times.

INTERFERENCE FASTENERS: All in this group, *Fig.* 3, lock by elastic or plastic flow of a portion of the fastener material. Nuts like Esna, Nylock and Pem utilize an elastic collar. This is of a plastic or fiber material which, being unthreaded, always tends to return to its original shape, and thus squeezes the bolt both axially and radially. Locking is due to inherent elasticity of the locking device and these fasteners will serve as stopnuts. In contrast to these are the rivet type of fastener such as Hi-Shear and Lockbolt wherein the metal is deformed past the elastic limit. In these instances there is, of course, no tendency to return to the original shape, and the fastener is permanently set. An interesting new development in this category is the Lok-Thred. This is a stud which utilizes a modification of the American National

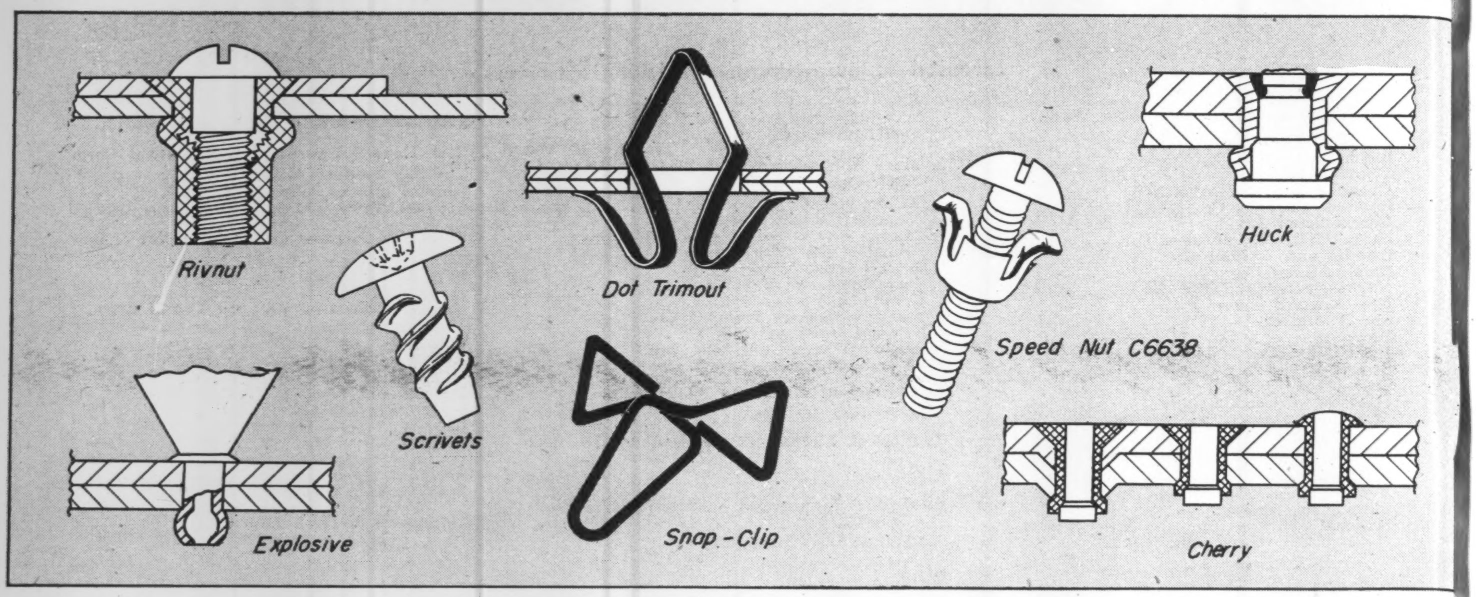


Fig. 5—BLIND FASTENERS: Used for fastening problems where there is no access to the back of the plate

thread. It is so designed, however, that it securely locks by an actual metal flow. The stud is said to have very high strength and to seal against leakage through the thread fastening.

Wedge-Locking Fasteners: Devices of this type lock by relative wedging of either two fastener elements, or nut and bolt, *Fig.* 4. Columbia lock-nut, for example, employs the relative wedging of two fastener parts for locking. The threaded inner and upper of these parts when tightened is forced downward, wedging within the inclined outer portion of the nut. Locking of this type of nut thus becomes more secure as the nut is tightened down. The familiar Dardelet thread utilizes the wedging principle in an entirely different manner. The root of the bolt thread and the ridge of the nut are both tapered. In the unlocked position these slopes are not in contact and the nut turns freely on the bolt. In tightening, however, the ridge of the nut thread is forced against the root of the bolt thread until the two tapers are wedged together in a locking action.

Blind Fasteners: A wide variety of principles is employed in this group. Some of them utilize spring action of the fastener, while others depend on plastic flow of the fastener material. *Fig.* 5 illustrates the general types available. Dot Trimount and Snap-Clip both employ a wire spring which, once inserted through an opening, expands and locks in position. Both of these are designed for light loads. Cherry, Explosive and Rivnut lock by plastic flow of the fastener metal. There is, however, a considerable difference in the methods used in achieving this flow. Explosive employs a small heat-sensitive explosive charge in the shank of the rivet. A hot iron applied to the rivet head quickly secures the fastener in place. Cherry, on the other hand, is set by the ironing action of a stem or plug which, when drawn through the hollow rivet by a "gun", expands the rivet tail and clinches the sheets being fastened together. Rivnut, like the Cherry rivet, is upset by use of a gun. In this case, a threaded stud on the gun engages interior threads on the rivet. Pull of the gun then

(*Concluded on Page* 184)

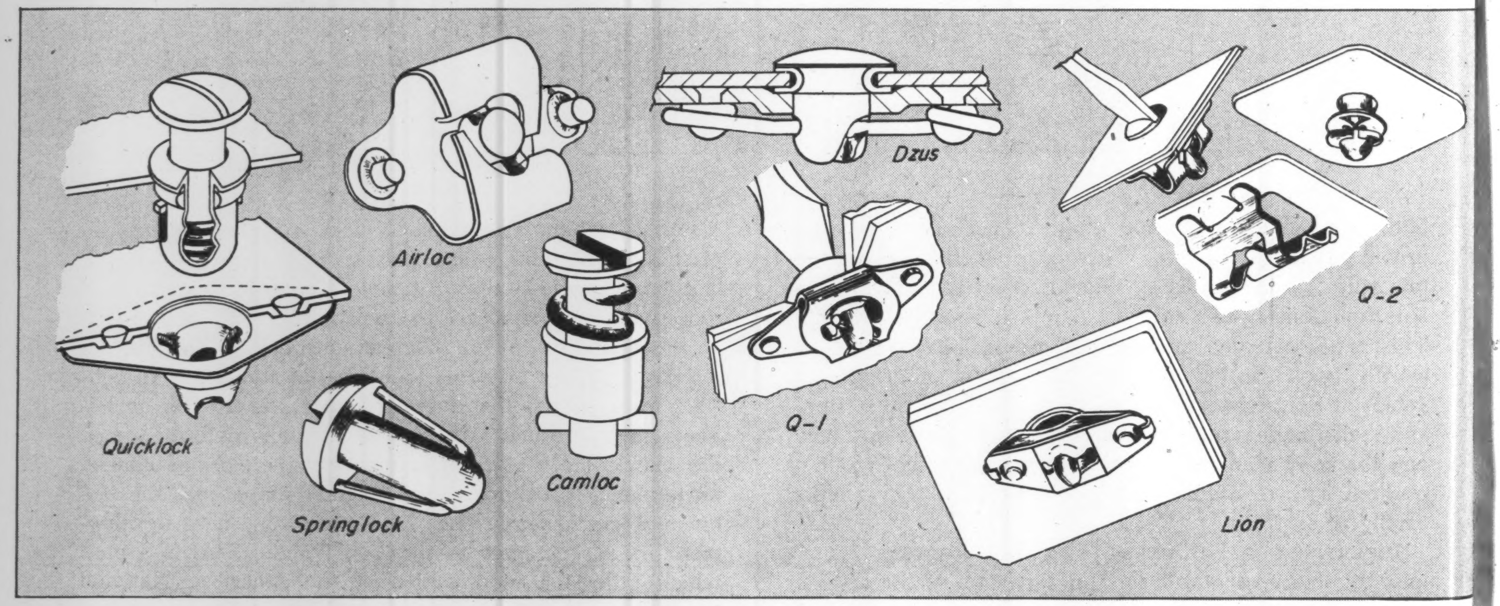


Fig. 6—QUICK-RELEASE FASTENERS: Locking or unlocking in a quarter turn, these are useful where parts must be removed often, for example, panels and doors

Preferred Numbers

. . . prove advantageous in designing a line of standard units

By Reynolds Olsen Tjensvold
Allis-Chalmers Mfg. Co.
Milwaukee

Fig. 1—These sheaves made in 150 sizes for either A or B-section V-belts are an example of the advantages of standardization by using preferred numbers

STANDARDIZATION in industry is the most important step in that evolutionary process where requirements are established for a variety of performances, objects, methods, capacities or other measurable concepts. Industrial standardization has thus been defined as the process which "refers to the setting up of fixed sizes, types, qualities, measures, etc. . . . (it) implies careful consideration of relationships and values usually involving scientific procedures." Standardization has become, in effect, a *base line* for engineers on which to establish fixed sizes, types, qualities and measurements.

Industrial standards have three sound bases for their establishment. They attempt to induce interchangeability, they tend to effect economies through reduction in the number of types and sizes, and finally, they establish accepted measures of excellence in quality and performance. Standardization aims to reduce any single line in fixed types, sizes and characteristics. A manufacturer of sheaves, for example, need not see every job for which the unit is used in order to build a sheave to fulfill certain requirements. Sizes of sheaves (*Fig.* 1) are picked in advance on the basis of sales experience and use, and the average industry will be able to find the sheave that will adequately serve to fill its needs. The same is true of electric motors, pumps (*Fig.* 2) for various purposes, crushers used in the mining industry, and screens for sifting.

However, standardization is not a wholly new concept nor even a recent development. As a matter of fact, standardization is one of civilization's oldest ideas inasmuch as the language with which we make ourselves understood and the alphabet used to write that language are "standards". Ancient history records that men made their lives simpler by adopting standard weights, measures and money with which to effect more rapid and economical trade and enterprise. There are known to be varying degrees of applicability of standards as well as numerous engineering features to be standardized upon, but a standard "reaches its highest degree of effectiveness when its requirements are stated in terms of measurement."

An interesting effort to apply rational methods to this problem of advance selection of the right size for manufactured items is found in the theory of preferred numbers. While it is agreed that standardization can be justified industrially only if it brings about economies without interfering with progress, far greater economies than at present might be secured by the adoption of more standardization. However, present practices for arriving at any standard are generally so cumbersome and time-consuming that the full value of the inherent economies is not always realized. This is as true of preferred numbers as it is of other types of standards. Preferred numbers are an excellent working tool for engineers and managements since their frequent and correct application may help speed the adoption of other standards as well.

The American Standards Association adopted the preferred numbers standards in 1936. During the past ten years an increasing number of industries have found value in this basic numerical standardization. Stripped of all mystery and of mathematical formulas and expressions, preferred numbers are simply groups of numbers which should be used in preference to any others whenever a standardization of ratings, dimensions, etc., is desirable.

Established Series Are Recommended

The association recommends that each designer and manufacturer avoid developing his own new "standards" where the accepted standards can be used. Similarly they warn against cluttering up standards with deviations that are not found in the tables. The common sense in this is readily apparent for, as ASA says, "In order to further standardization, it is essential that the Preferred Numbers given in the tables be used".

Preferred numbers, as established by ASA are listed in Table I. Also included in this table are 80 series for both decimals and fractions. Their basic feature is simply geometric progression, with each number in the series greater than the one which preceeds it by a fixed percentage. It is recommended that for any given line or group of materials "the same series should be adhered to over as wide a range as possible, but a change from one series to another is frequently necessary in order to obtain the maximum utility and economy in the particular case involved". They recommend that the numbers in the 5-series be given preference over the 10-series, the 10-series over the 20-series, and so on. However, if the integration of an existing line of products with a preferred numbers series demands it, a designer or manufacturer may cast the first half of his sizes in the 10-series and the second half in the 20-series. Obviously, he is adhering to the principles involved if he follows the accepted preferred numbers and whatever interchange is necessary may be made consistently within the system.

When the design or the item in manufacture dictates a smaller size (as some hardware and stock items frequently do) the whole numbers may be inadequate. For these, the fractional series in Table II and its variations are acceptable. Table III shows supplementary series of preferred numbers for decimal series from 1 to 1000 and fractional series from ⅛ to 40.

Outside of the United States the decimal system and metric scales are almost universally used. But American Standard preferred numbers has anticipated this situation by providing for the constant conversion from inches to centimeters. The standard covers this by stating:

> It so happens that the conversion factor of 2.54 for changing inches to centimeters is approximately a Preferred Number. Therefore, when converting inch values of the decimal Preferred Numbers system into metric

TABLE I—Preferred Numbers—Decimal and Fractional Series

Decimal Series (10 to 100)					Fractional Series (⅜ to 40)	
5 Series 60% Steps	10 Series 25% Steps	20 Series 12% Steps	40 Series 6% Steps	80 Series 3% Steps	80 Series ⅜ to 3⅞ 3% Steps	80 Series 4 to 39 3% Steps
10	10	10	10	10 10.3	3/8 25/64	4 4 1/8
			10.6	10.6 10.9	13/32 27/64	4 1/4 4 3/8
		11.2	11.2	11.2 11.5	7/16 29/64	4 1/2 4 5/8
			11.8	11.8 12.1	15/32 31/64	4 3/4 4 7/8
	12.5	12.5	12.5	12.5 12.8	1/2 33/64	5 5 1/8
			13.2	13.2 13.6	17/32 35/64	5 1/4 5 3/8
		14	14	14 14.5	9/16 37/64	5 1/2 5 5/8
			15	15 15.5	19/32 39/64	5 3/4 5 7/8
16	16	16	16	16 16.5	5/8 41/64	6 6 1/4
			17	17 17.5	21/32 43/64	6 1/2 6 3/4
		18	18	18 18.5	11/16 45/64	7 7 1/4
			19	19 19.5	23/32 47/64	7 1/2 7 3/4
	20	20	20	20 20.6	3/4 25/32	8 8 1/4
			21.2	21.2 21.8	13/16 27/32	8 1/2 8 3/4
		22.4	22.4	22.4 23	7/8 29/32	9 9 1/4
			23.6	23.6 24.3	15/16 31/32	9 1/2 9 3/4
25	25	25	25	25 25.7	1 1 1/32	10 10 1/4
			26.5	26.5 27.2	1 1/16 1 3/32	10 1/2 10 3/4
		28	28	28 29	1 1/8 1 5/32	11 11 1/4
			30	30 30.7	1 3/16 1 7/32	11 1/2 11 3/4
	31.5	31.5	31.5	31.5 32.5	1 1/4 1 9/32	12 12 1/2
			33.5	33.5 34.5	1 5/16 1 11/32	13 13 1/2
		35.5	35.5	35.5 36.5	1 3/8 1 13/32	14 14 1/2
			37.5	37.5 38.7	1 7/16 1 15/32	15 15 1/2
40	40	40	40	40 41.2	1 1/2 1 9/16	16 16 1/2
			42.5	42.5 43.7	1 5/8 1 11/16	17 17 1/2
		45	45	45 46.2	1 3/4 1 13/16	18 18 1/2
			47.5	47.5 48.7	1 7/8 1 15/16	19 19 1/2
	50	50	50	50 51.5	2 2 1/16	20 20 1/2
			53	53 54.5	2 1/8 2 3/16	21 21 1/2
		56	56	56 58	2 1/4 2 5/16	22 22 1/2
			60	60 61.5	2 3/8 2 7/16	23 23 1/2
63	63	63	63	63 65	2 1/2 2 9/16	24 25
			67	67 69	2 5/8 2 1/16	26 27
		71	71	71 73	2 3/4 2 3/16	28 29
			75	75 77.5	2 7/8 2 15/16	30 31
	80	80	80	80 82.5	3 3 1/8	32 33
			85	85 87.5	3 1/4 3 3/8	34 35
		90	90	90 92.5	3 1/2 3 5/8	36 37
			95	95 97.5	3 3/4 3 7/8	38 39

Preferred numbers below 10 are formed by dividing the numbers between 10 and 100 by 10, 100, etc. Numbers above 100 are correspondingly formed by multiplying by 10, 100, etc.

While there are few applications requiring steps smaller than the six per cent steps of the 40 series such cases may nevertheless occur at times. Therefore an 80 series, both decimal and fractional, has been adopted. The numbers of this series should also be useful in many cases in actual practice where it is necessary to standardize two values which should be rather close together and where a difference of three per cent is suitable. One of the values can be chosen from one of the coarser series and the other can be the value of the 80 series immediately following. Where it is desirable to have a 9 per cent increase in steps, every third value in the 80 series may be used.

Percentage steps in headings are approximate averages.

units, the results will again be approximate Preferred Numbers (within 1.6%). This approximation in many cases is satisfactory from a practical point of view. With the fractional system the discrepancies are much greater (up to about 5%) and therefore standardization of linear dimensions that may become important internationally should preferably be by use of the decimal series of Preferred Numbers.

Many possible industrial applications of preferred numbers may be made if the system is applied to only the simplest devices. There are also many conditions where complex interrelationships in dimension or ratings make the application of the series more difficult if not impossible. However, the leading proponents of preferred numbers have been industrial men and they have believed from the outset that solutions can be worked out if common sense is used and the ever-present economic factors are borne in mind.

In a new industry it may be difficult to establish standards since generally but few trade associations or other organizations are given the authority to define and recommend the application of any standards. The use of preferred numbers can avoid such wastefulness, however, for it is available and coming into such general use that a wide range of standards are accepted long before standardization of complete products by associations will become feasible for an entire line.

May Reduce Costs

Probably the main objections to accepting preferred numbers have been raised because the engineers were not fully aware of their functions or of how to introduce them into new products. Practical economy may determine that immediate application of preferred numbers is not worthwhile even though it may be possible, in principle, to use them. When new products are being developed, as well as when old ones are being changed or redesigned, the series suggested can be applied, often at a saving. Some companies have evolved their own "standards". If this is the case, it follows that since some standards are deemed necessary, preferred numbers may serve as well as these more arbitrary choices. The parts may then be interchangeable, but if not, at least they will be put on an industry-wide basis of understandable description. When later developments in the product are made, they can be integrated with the earlier ones on the basis of accepted standards which are logical

TABLE II—Preferred Numbers—Basic Fractional Series

⅛ to 1				1 to 10				10 to 40			
5 Series 60% Steps	10 Series 25% Steps	20 Series 12% Steps	40 Series 6% Steps	5 Series 60% Steps	10 Series 25% Steps	20 Series 12% Steps	40 Series 6% Steps	5 Series 60% Steps	10 Series 25% Steps	20 Series 12% Steps	40 Series 6% Steps
				1	1	1	1	10	10	10	10
							1 1/16				10½
						1⅛	1⅛			11	11
							1 3/16				11½
	⅛	⅛			1¼	1¼	1¼		12	12	12
							1 5/16				13
		9/64				1⅜	1⅜			14	14
							1 7/16				15
5/32	5/32	5/32		1½	1½	1½	1½	16	16	16	16
							1⅝				17
		11/64				1¾	1¾			18	18
							1⅞				19
	3/16	3/16	3/16		2	2	2		20	20	20
			13/64				2⅛				21
		7/32	7/32			2¼	2¼			22	22
			15/64				2⅜				23
¼	¼	¼	¼	2½	2½	2½	2½	24	24	24	24
			17/64				2⅝				26
		9/32	9/32			2¾	2¾			28	28
			19/64				2⅞				30
	5/16	5/16	5/16		3	3	3		32	32	32
			21/64				3¼				34
		11/32	11/32			3½	3½			36	36
			23/64				3¾				38
⅜	⅜	⅜	⅜	4	4	4	4	40	40	40	40
			13/32				4¼				
		7/16	7/16			4½	4½				
			15/32				4¾				
	½	½	½		5	5	5				
			17/32				5¼				
		9/16	9/16			5½	5½				
			19/32				5¾				
⅝	⅝	⅝	⅝	6	6	6	6				
			21/32				6½				
		11/16	11/16			7	7				
			23/32				7½				
	¾	¾	¾		8	8	8				
			13/16				8½				
		⅞	⅞			9	9				
			15/16				9½				

Beyond 40 the fractional preferred numbers are the same as the decimal preferred numbers, see TABLE I.

Below ⅛ the decimal series will be used.

Below 3/16 the steps of the 40 series are omitted as finer gradations will seldom be used.

The basic preferred numbers system, being an international system, is based on the use of decimals. But as the use of fractions has become so thoroughly established in the inch system of measurement, a fractional system over the range between ⅛ inch to 40 inches was devised. In order to make this system conform to well-established practices, the selected figures do not conform as closely to the theoretical values as the figures in the decimal system, the discrepancy being as much as 4 to 6 per cent in some cases. The maximum difference between values of the decimal and corresponding fractional systems is 6.3 per cent.

TABLE III—Supplementary Series of Preferred Numbers

Decimal Series—1 to 1000				
5/2 Series 150% Steps	5/3 Series 300% Steps	10/3 Series 100% Steps	20/3 Series 40% Steps	40/3 Series 18% Steps
1	1	1	1	1
2.5				1.18
6.3			1.4	1.4
16				1.7
40		2	2	2
100				2.36
250			2.8	2.8
630				3.35
	4	4	4	4
				4.75
			5.6	5.6
				6.7
		8	8	8
				9.5
			11.2	11.2
				13.2
	16	16	16	16
				19
			22.4	22.4
				26.5
		31.5	31.5	31.5
				37.5
			45	45
				53
	63	63	63	63
				75
			90	90
				106
		125	125	125
				150
			180	180
				212
	250	250	250	250
				300
			355	355
				425
		500	500	500
				600
			710	710
				850

Fractional Series—⅛ to 40				
5/2 Series 150% Steps	5/3 Series 300% Steps	10/3 Series 100% Steps	20/3 Series 40% Steps	40/3 Series 18% Steps
		⅛	⅛	
			11/64	
				13/64
	¼	¼	¼	¼
				19/64
			11/32	11/32
				13/32
		½	½	½
				19/32
5/32			11/16	11/16
⅜				13/16
1	1	1	1	1
2½				1 3/16
6			1⅜	1⅜
16				1⅝
40		2	2	2
				2⅜
			2¾	2¾
				3¼
	4	4	4	4
				4¾
			5½	5½
				6½
		8	8	8
				9½
			11	11
				13
	16	16	16	16
				19
			22	22
				26
		32	32	32
				38

Preferred numbers below 1 are formed by dividing the numbers between 1 ond 1000 by 1000. Numbers above 1000 are correspondingly formed by multiplying by 1000.

Supplementary series are selected from the basic series and are used where percentage steps above 60 or between 60 and 25 or 25 and 12 are necessary for some justifiable reasons.

and widely applicable.

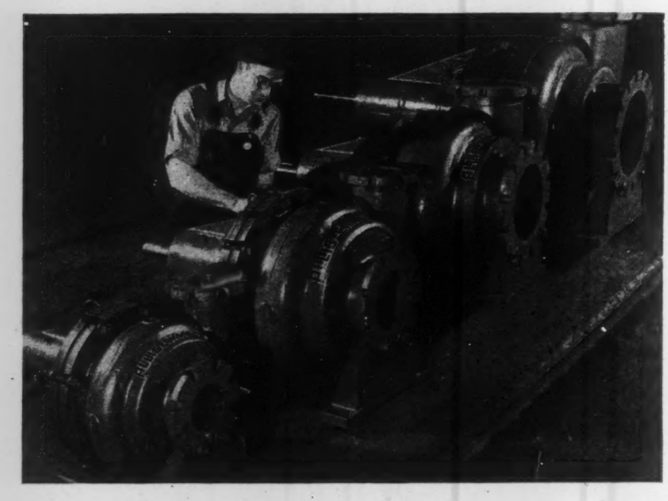
One problem confronting engineers is to design a unit in accordance with preferred numbers standards and yet maintain the integrity of its past design. For example, a container may be standardized for some use with the cubic content and two dimensions being preferred numbers. But neither the third dimension nor the weight of the material used could be preferred numbers because of a definite relationship that must exist between all the factors. Questions like these must be settled on their individual merits —such as past practice or end-use determinations.

Since the early 1920's various organizations in this country have worked to develop a system of preferred numbers which might be accepted and used effectively by American industry. The tables as recommended by the ASA sectional committee on classification of materials for tools, fixtures and gages were first formulated in 1927. Apparently considerable resistance was offered to the introduction of this idea. Much of the difficulty could be traced to the usual problems inherent in displacing the then-existing standards which were deeply rooted although not nearly as simplified nor universally applicable as preferred numbers. Furthermore, industry balked at the idea of the heavy expenditures that would be involved in making conforming changes in drawings, tools and dies.

The first draft of the proposed preferred numbers was sent out for comment and criticism in 1934. With only a few modifications this draft was approved by the committee in 1935. The standards were accepted and published, giving the following definition:

> Preferred numbers are series of numbers selected to be used for standardization purposes in preference to any other numbers. Their use will lead to simplified practice and they should, therefore, be employed whenever possible for individual standard sizes and ratings, or for a series thereof, in applications similar to the following:
>
> Important or characteristic linear dimensions, such as diameters and lengths
> Areas, volumes, weights, and capacities
> Ratings of machinery and apparatus in horsepower, kilowatts, kilovolt-amperes, voltages, current, inductances, capacitances, speeds, power-factors, pressures, heat units, temperatures, gas or liquid-flow units, weight-handling capacities, etc.
> Characteristic ratios of figures for all kinds of units.

Fig. 2—These pumps are built in seven sizes, four of which are illustrated



As an example of the use of such preferred numbers, the electrical industry has attempted to devise many standards in its field, but years passed between the development of the first commercially acceptable electric motor and the adoption of the preferred numbers system.

Each motor manufacturer established his own range of sizes of motors. One might build motors of 20, 30, 40, 50 and 75 horsepower. Another would build motors of 20, 25, 50, 60 and 75 horsepower. Soon the first would introduce 25 and 60 horsepower motors "to meet the competition". Then the latter would justify a 30 horsepower motor on the same basis. The confusion was colossal. Customers didn't help when they demanded 33 or 66 horsepower motors. The bill, as usual, was paid by the customer. It took some time for him to admit that there were savings in standard rated motors. When he did, competition took a firm hand in forcing the acceptance of standard sizes. Even with this realization, however, it took thirty or more years before this costly program was eliminated by the joint action of the electrical motor manufacturers through the adoption of NEMA standards which co-ordinate clearly with preferred numbers. Now the problem is being met in other types of apparatus.

European engineers studying preferred numbers found that the human mind more naturally accepts geometric progression than arithmetic in determining a series of graded sizes. Stores carried all varieties of sizes on their shelves, but certain sizes "moved" better than others. Inquiry into this phenomenon led to the determination of these accepted standards. Thus, if we were to plot these standard sizes (of bolts, wire or pipe) as ordinates against serial numbers as abscissas, all would fall along curves that are roughly parabolic in outline. The French and German engineers who exploited these facts of "normal" preference anticipated American action on the same subject by nearly half a century.

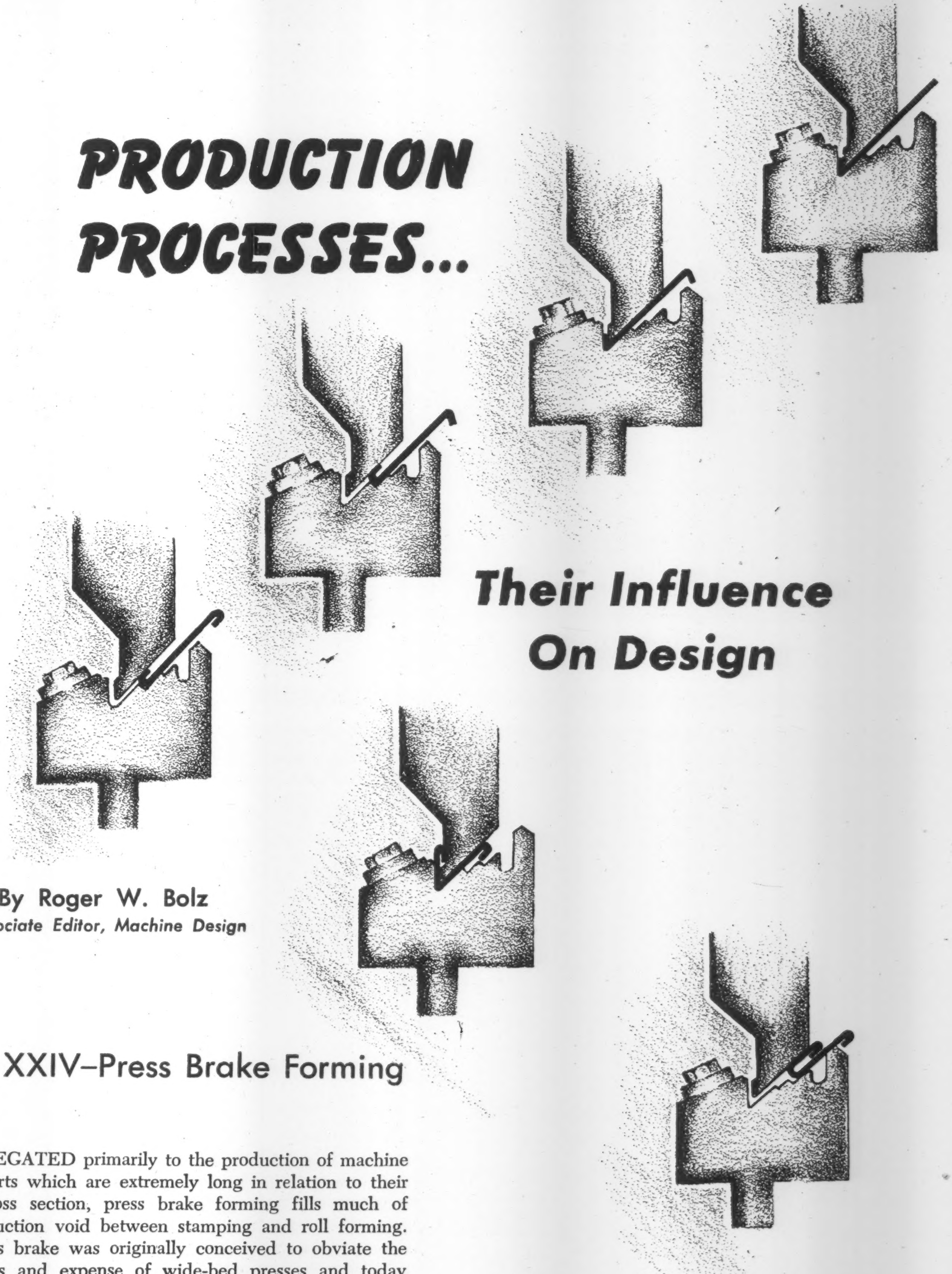
Acceptance Has Lagged

In spite of the adoption of these standards, there has been a considerable lag in their acceptance in industry. This may be accounted for, in part, by the limited amount of information made available to engineers on this subject. It is more likely due to the mistaken belief that preferred numbers are esoteric or, at best, too difficult to understand. Neither belief is correct.

In essence, the system of preferred numbers is a simple means of arriving at a minimum necessary number of dimensions for any given device which will meet its service requirements adequately. A marked value of preferred numbers is that they provide for the addition of more sizes or types if the original range is incomplete. And—most importantly—the later additions may be logically fitted into the original series.

The development is so reasonable that it is surprising to find its present application as limited as it is. In most cases the introduction of preferred numbers could come about naturally. Even in those few cases where complex relationships exist which are not provided for within the standards, it may be possible to find one or more advantageous applications of the series. It cannot be overemphasized that preferred numbers may be used extensively, but engineers must be governed by the utility of the plan and the economy of the structure they are building. These alone will limit their application.

PRODUCTION PROCESSES...



Their Influence On Design

By Roger W. Bolz
Associate Editor, Machine Design

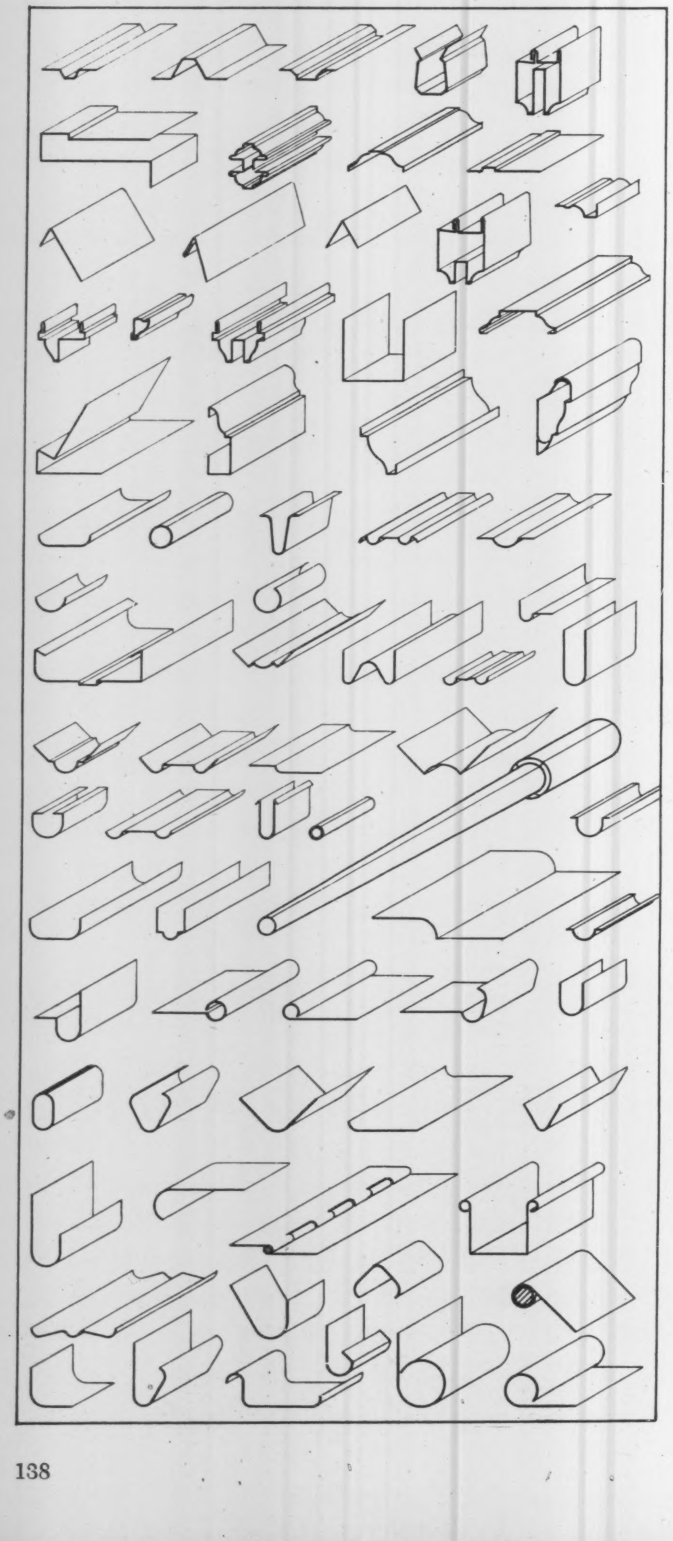
Part XXIV–Press Brake Forming

RELEGATED primarily to the production of machine parts which are extremely long in relation to their cross section, press brake forming fills much of the production void between stamping and roll forming. The press brake was originally conceived to obviate the limitations and expense of wide-bed presses and today offers a highly versatile, economical means for producing parts from sheet and plate which necessitate a long, narrow forming bed.

Although the press brake is largely used and suited for performing long bending or forming not adapted to regular presses, *Fig.* 1, a wide variety of blanking, punching, notching, coping, lockseaming, beading, wiring, and similar operations is readily accomplished. Machine parts produced cover a tremendously varied field including such components as shells, frames, tubular sections either uniform or tapered in length, cabinets or housings, structural sections of almost any cross-sectional design, etc. Generally, the work must be such that it can be produced on a long, narrow press bed with a relatively short ram stroke, *Fig.* 2, and is normally confined to sheet metal or plate material although insulation board, pressed wood, rubber and similar materials have been handled.

Many types of press brakes are now available, some being more accurately termed open-front presses. These range in bed width up to 42 inches, *Fig.* 3, with some special presses even greater. Press sizes range from small machines with a capacity around 20 to 25 tons for light bending up to 4 feet in length with 14-gage sheet to around 900 tons for heavy work. Bed lengths respectively run from 6 to 30 feet. A standard 900-ton press, *Fig.* 4, with V-die bending will handle 1-inch plate 12 feet long, ¾-inch plate 20 feet long, or ½-inch plate 30 feet long. Special presses are available, however, which are capable of handling 1-inch plate 50 feet in length. Where extra length is necessary, presses often can be used in tandem, *Fig.* 5, to achieve the desired results, although interlocking the clutch controls presents a complication.

Fig. 1—Below—A representative group of cross sections showing the general type and range of brake operations



Ram stroke required in the forming of parts must be relatively small, in general not over 6 inches, the longest stroke available in present machines being around 8 inches or so. Standard brakes, however, are usually made with a 3 or 4-inch stroke. Simple adjustment provided on the ram and means for exactly recording such adjustments for duplication makes possible the forming of many parts not possible by any other method. This is especially true with work which must rise in front of or behind the dies during forming. Again, work is not limited to the machine ram length, inasmuch as parts properly designed can be

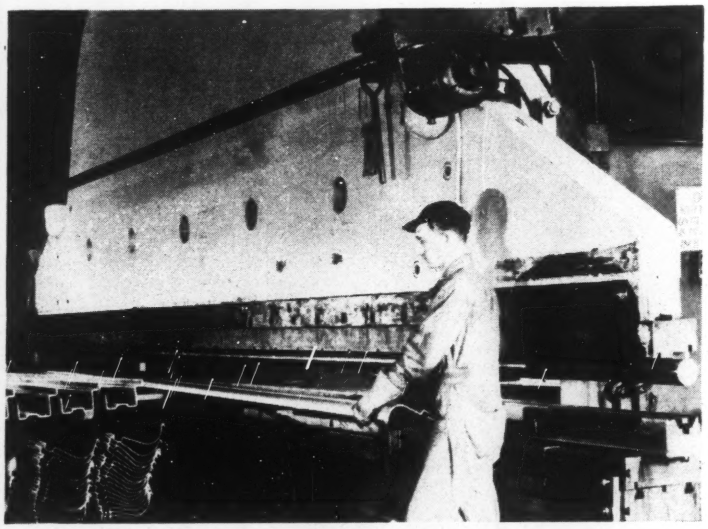
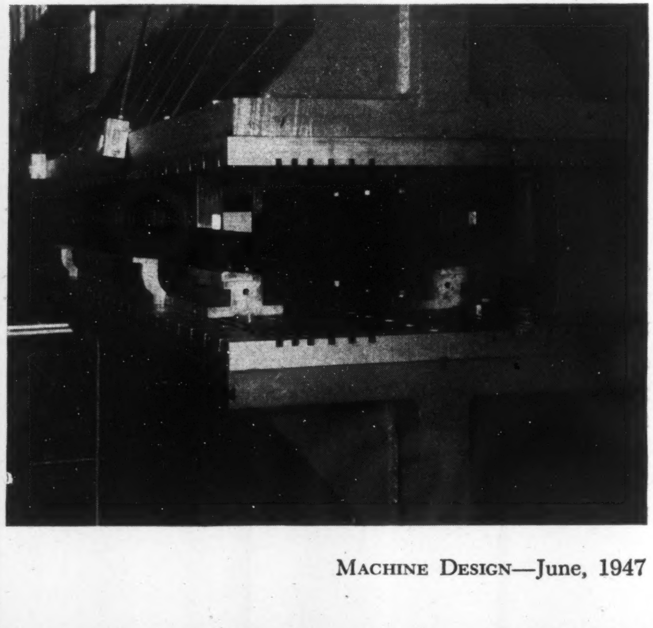


Fig. 2—Above—Trailer rib sections, 30 feet long, being formed from 12-gage mild steel on a 900-ton brake

Fig. 3—Below—Press with a 42-inch wide special bed indicates the versatile nature of press brake forming



progressed through in stages when necessary by virtue of the open construction at either end of a press brake, *Fig.* 6. Where extremely wide work is to be produced, design of the part must be such as to allow the load to be reasonably well centered under the bed and ram, *Fig.* 3.

A press brake is considerably different from either a press or a roll former from the standpoint of tool cost. Most of the factors which it is necessary to consider before tooling the latter machines need not be considered when designing for the press brake. A few standard dies will produce a great variety of parts and are relatively inexpensive, *Fig.* 7. By the use of "air bending", one set of acute-angle bending dies will form angles of any degree required by merely controlling the distance to which the punch enters the die opening.

For parts not suited to stamping, roll forming or similar methods, production on the press brake is highly economical even though in certain cases quantities may run to fairly high figures. Naturally where design and quantity are well suited to either of these other methods, lowest costs and highest output speed can be realized.

Standard brakes operate between about 5 and 50 strokes per minute. Handling of parts, however, sets the actual production capacity. Exremely large parts such as shown in *Fig.* 4 or *Fig.* 5 would probably reach only a few parts per hour while with smaller parts, in some cases with automatic feed, production output may average around 500 per hour. Multiple operations can be used on one machine to achieve rapid production, as many as ten separate functions being possible. Owing to the simplicity and low cost of the tooling on press brakes, trimming, punching, forming and similar operations are regularly performed in this manner in the production of cabinets, doors, tops, frames and panels on refrigerators and like equipment. Too, by this method unusual freedom can be had in the way of design improvements since changes in tooling would incur relatively little cost. An outstanding illustration of this progressive production setup can be seen in *Fig.* 8, which shows the various steps in producing a relatively small number of cabinets which achieve not only economy in manufacture but also the merits of interchangeable mass-produced parts.

DESIGN: Insofar as design of parts is concerned, few general rules can be applied. Press brakes as well as dies for performing ordinary as well as an unlimited number of special-purpose operations are extremely flexible and provide great freedom for the designer. However, a number of normal limitations should be kept in mind in order

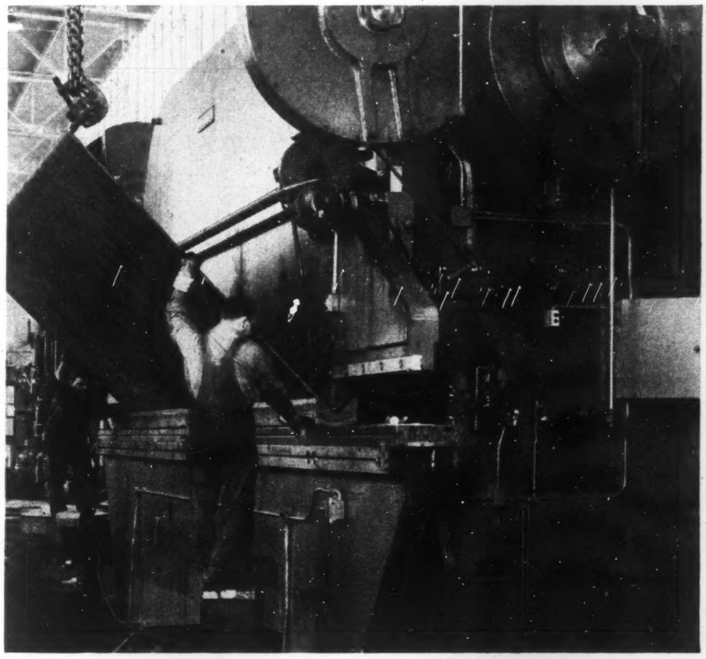


Fig. 4 — Above—Heavy plate bending with a 900-ton press brake

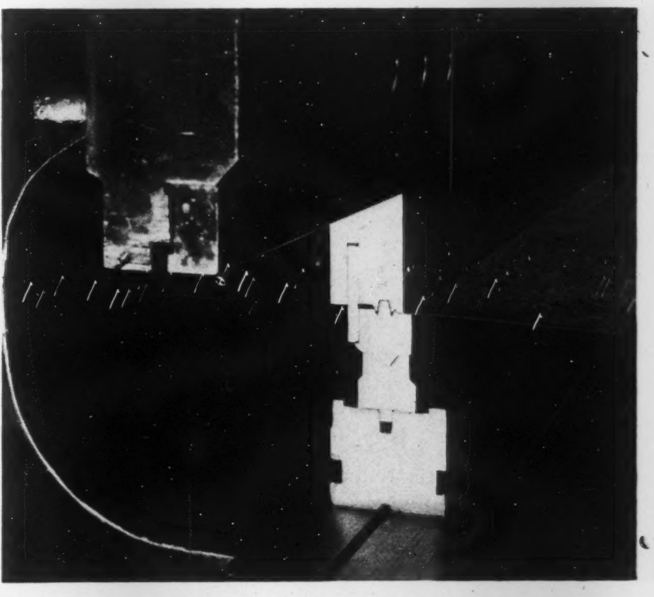


Fig. 6—Above—Open end construction of standard press makes practicable the forming of extra long parts

Fig. 5—Right—Two press brakes being used in tandem to form tapered octagonal sections from alloy-steel sheet

to simplify production and achieve low cost of parts. Several points which should be kept in mind and which have been indicated previously are: (1) Work or operations to be performed should be such that they can be fairly symmetrical under the centerline of the ram, meaning front to rear; (2) material to be employed is normally in sheet or plate form; and (3) design should be such that the stroke available on press brakes will give proper clearance for easy and rapid handling.

Design for brake forming normally should avoid the necessity for making any but the simplest, shallow draws. Wherever possible, drawing should be obviated by using notched corners and welding, by adding welded ball corners, etc. Consideration should be given the distances between notches, holes, etc., so that simple tooling can be used as well as single-stroke production allowed. Since these conditions vary somewhat according to press size and design, doubtful designs should be discussed with the manufacturer or production department prior to completion.

Certain parts can be designed so as to lend themselves to progressive operations, *Fig.* 9, especially where quantity will warrant expenditure on a special die arrangement. For example, where two operations are planned, these may be formed in double-deck dies in one handling. Here it is essential, however, that one operation be at the edge of the sheet so that it can be performed in the upper die, and the stroke required on both forming operations should be such that the press stroke will handle the two with reasonable room for removal, *Fig.* 10.

Where length of work contemplated is well within the clear distance between the brake housings, there is relatively no limit to the size of flange that can be formed, but when parts require the total overall die surface or more, flange width is limited by the depth of the throat of the brake. For instance, the clear distance available on a 6-foot brake is about 4½ feet, that of a 10-foot machine is about 8½ feet, that of a 20-foot is about 16½ feet, etc. Available throat clearance of presses up to 150-ton and 14-foot length is about 8 inches, from 200 to 250-ton in lengths from 8 to 14 feet is about 10 inches, and from 335 to 900

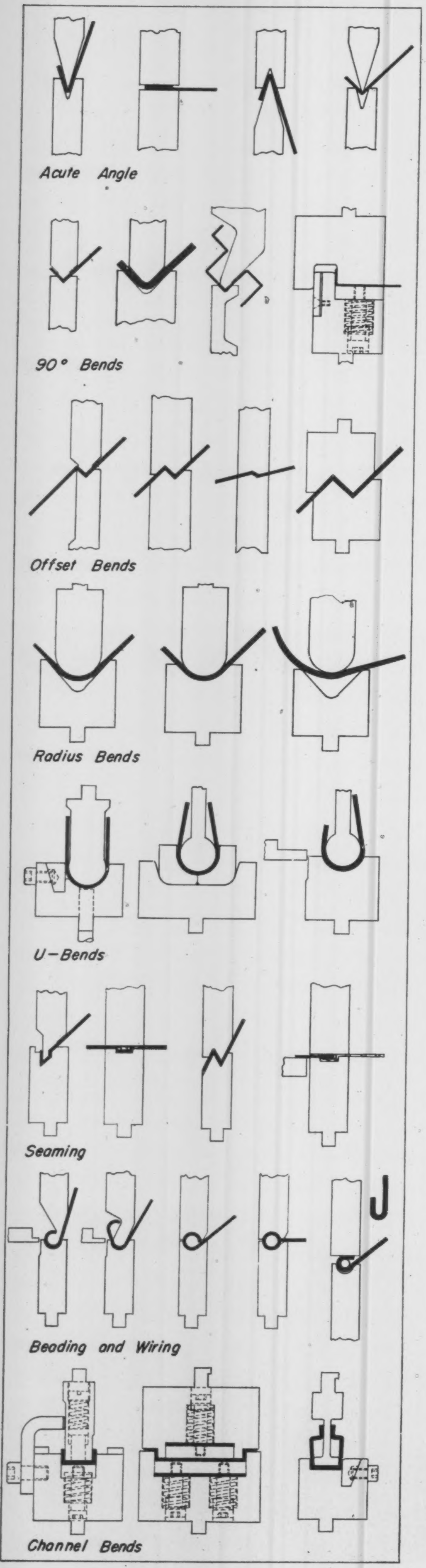


Fig. 7—Left—A group of representative press brake forming die sets which illustrate the multitude of forms which can be produced

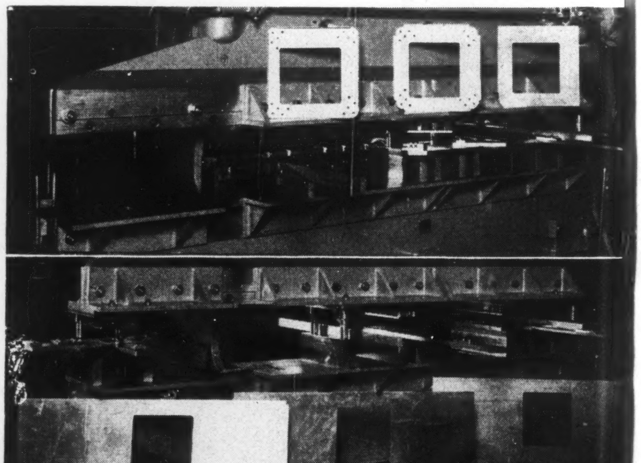


Fig. 8—Right— Progressive setup for economically producing cabinets in relatively limited quantities

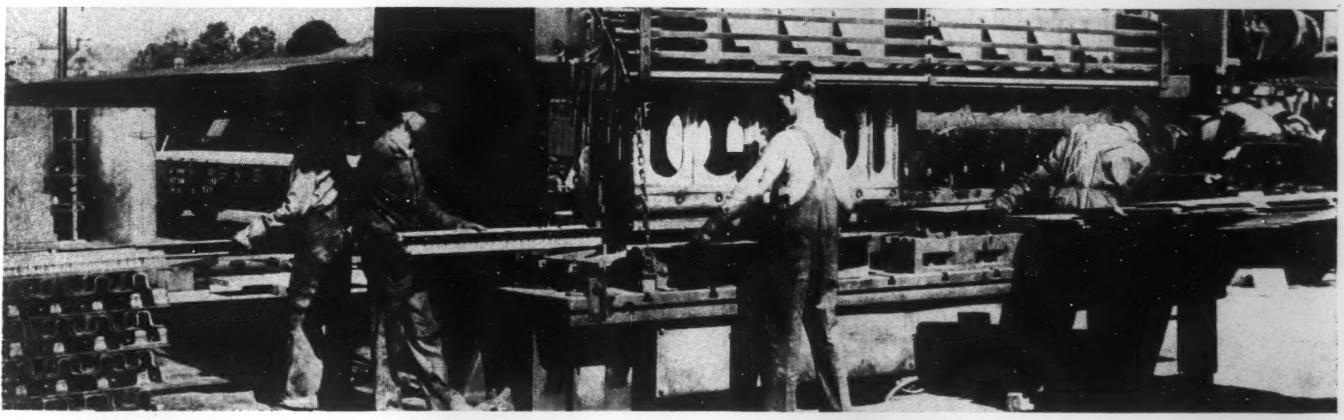


Fig. 9—Above—Gondola car stakes being formed progressively. Die at the right punches the holes, die at the left front makes the first forming operation while that in the rear finish forms

ton and 8 to 20-foot lengths is about 14 inches. Parts which can be formed at the extension as in *Fig.* 8, of course, are relatively unrestricted and can be completely closed if desired.

Forming capacities of brakes are based on "air bends" where the material contacts only two lines on the female die and the extreme point of the male die. Such bends require the least pressure and normally are made on a V-die with an opening 8 times the metal thickness which results in an inside radius approximately equal to the metal thickness. Sharper radii necessitate the use of "bottoming" dies and a considerable increase in pressure so should be avoided if at all possible. Likewise, a female die opening of less than 8 times the metal gage requires increased forming pressure as the opening decreases. Thus, since the minimum flange that can be formed on any die is approximately one-half the die opening plus two times the metal thickness, flange dimensions should be based on the ideal die opening of 8 times gage or, wherever possible, greater. Flanges smaller than these necessitate the use of confining forming dies similar to those used in stamping and naturally incur greater cost per piece. With plate over ½-inch in thickness die openings should be considerably greater than 8 times gage to prevent the tendency toward fractures.

Numerous methods are employed to calculate the blank size of metal, especially where 90-degree bends are used. Most are only empirical and depend upon uniform gage, hardness, direction of grain, and speed of forming. For accurate results, especially with large radii or unusual shapes, actual check is recommended. Developed width of simple sections and multiple-bend sections can be found from the formulas shown in *Fig.* 11. Note that simple bends having corner radii approximately equal to the gage are usually dimensioned from the inside and mutiple bends having radii *not* equal to the gage are dimensioned from the outside.

As previously mentioned, a wide variety of punched, blanked, pierced, notched, formed, and combination designs can be produced on the press brake. Standard die sets as well as special ones are available in separate units which can be attached to the press, *Fig.* 8, in the relation desired to achieve an almost unlimited variety of designs. A few of these are shown in *Fig.* 12 to indicate the range available. Plain holes in nominal sizes from 1/32 to 1½ inch can be specified in almost any arrangement. However, spacing between holes or hole to edge of the sheet should usually be ½-inch or greater though in certain cases this can be reduced to about one thickness of the stock used.

MATERIALS: In selecting materials for parts to be brake formed, strength, cost, etc., govern the selection to a great degree. Problems encountered in forming various materials are largely the same as those found with other forming processes. Mild steel is by far the most common material employed and is well suited to brake work. Materials having a high degree of hardness present considerable difficulty in springback variations due to gage and temper variations. Hard cold-

Fig. 10—Below—Cross section of a double-deck die for performing two operations

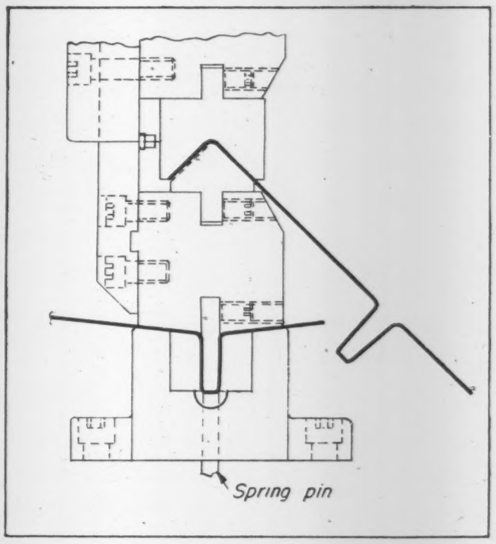
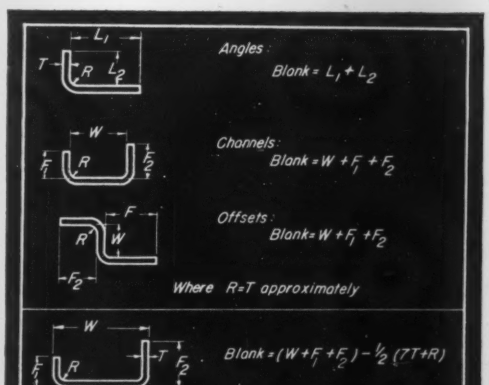


Fig. 11—Below—Formulas and data for determining the blank width of single and multiple-bend sections



rolled sheet, high-tensile steels, heat-treated aluminum alloys and like materials usually offer many difficulties in brake forming which naturally involve increased production costs because of more expensive dies, continual adjustments, etc. For example, in forming the corrugated aircraft panel, *Fig.* 13, a great many adjustments were necessary on the die, even when sheets were from different heats. Too, gage variations on thin materials, i.e., 0.001-inch on 0.050-inch sheet, in this case, required a ram adjustment of 0.005-inch to hold pitch dimensions. Such difficulties, of course, influence production speed considerably.

Dies built for common mild steel seldom are satisfactory for terne plate, zinc, bronze, copper, etc., without auxiliary operations or hand work. However, where quantities required do not justify special dies for a change in material, this procedure is employed as most satisfactory and economical.

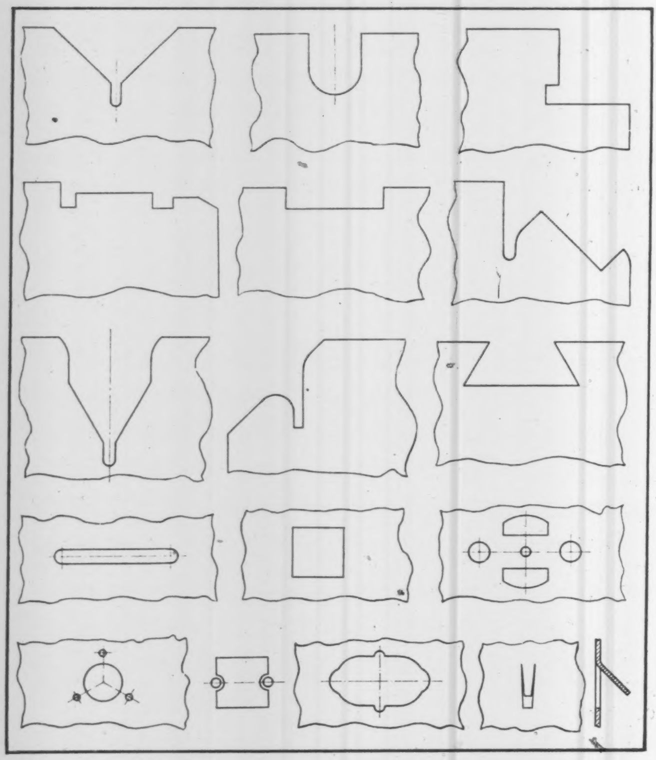
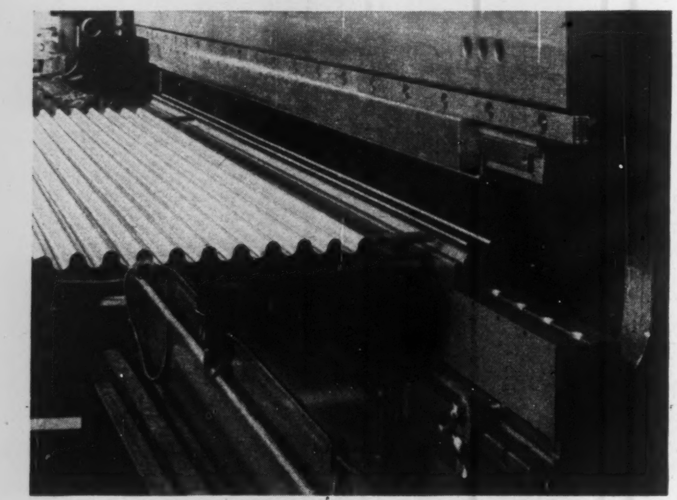


Fig. 12—Above—Some of the various shapes and hole combinations which can be perforated with available dies

Fig. 13—Below—Long, deep-corrugated aluminum aircraft panel brake-formed in large quantities



Bending pressure varies directly as the tensile strength regardless of the type of material—straight-carbon steel, high-tensile alloy steel, stainless steel, etc. Where materials whose tensile is greater than that of mild steel are used, radii larger than the gage should be contemplated to ease the bending requirements, especially where parts are long. High-tensile steel plate, even in the thinner gages, usually must be formed over die openings ten to twelve times gage to prevent fracture. Often special flanging or boiler steel is employed to obviate breakage when heavy gages must be bent over a small die opening for proper radius.

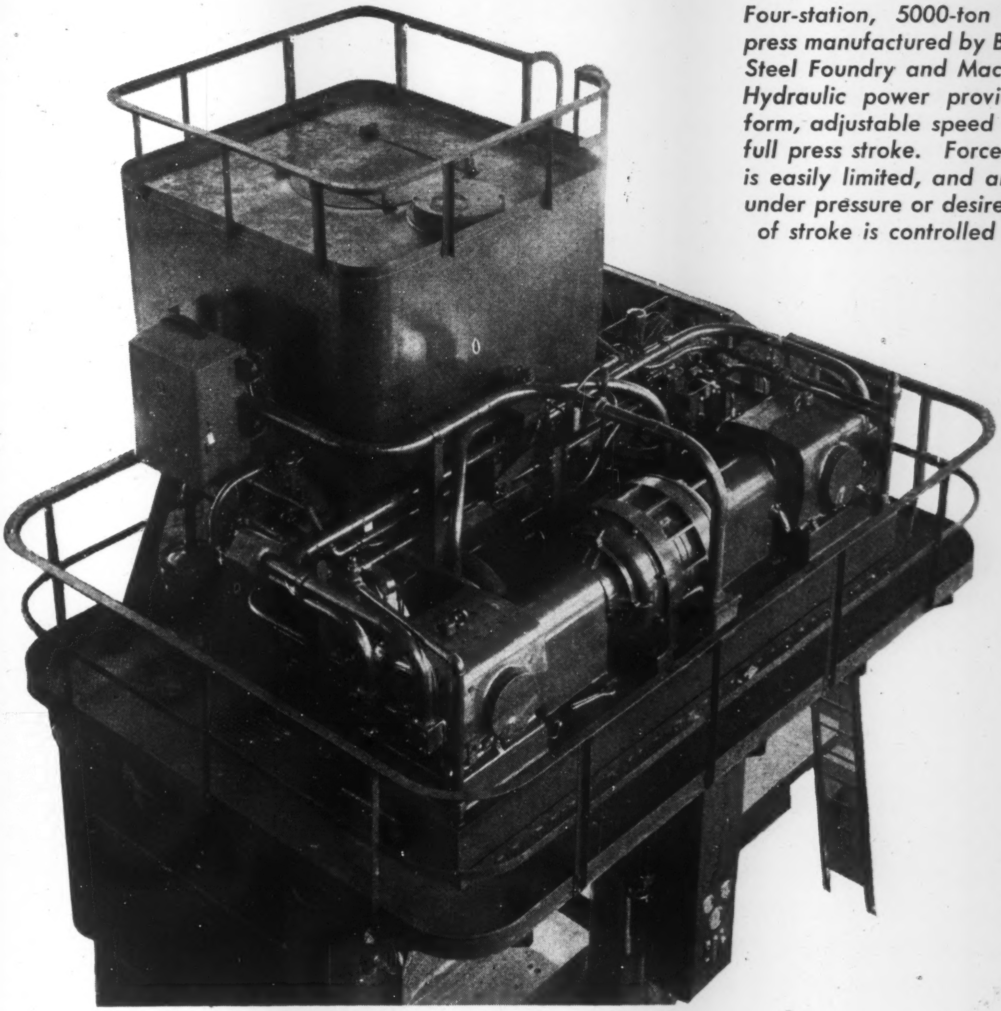
TOLERANCES: As usual, consideration must be given to keeping tolerances no closer than the method of manufacture makes practicable. It will be readily recognized from the foregoing discussion that tolerances readily held in economical production on the press brake usually must be considerably wider than those normally specified in machining, stamping or roll forming. Unless relatively large quantities are involved and expensive special dies are warranted, tolerances on simple sections up to about 6 inches should be around plus or minus 0.031-inch, especially where length is considerable. Naturally where short parts are produced, say up to 6 feet in length, closer tolerances can be held but are dependent to a great extent upon uniformity of gage, temper, etc. Large sections or complicated designs, *Figs.* 4 and 5, for economical reasons should have wider tolerances, say plus or minus 0.062-inch.

Parts completely formed in the dies, *Figs.* 2 and 8, can be held to limits normally expected in the usual run of similar stamping or drawing operations, say plus or minus 0.015-inch average. Accuracies of blanked and pierced parts such as shown in *Fig.* 8 will depend upon the type of die used; wide tolerances allowing the use of low-cost "temporary" or "adjustable" dies in many cases. Normally, this would set the practical tolerances for blanked parts at, say, plus 0.010-inch minus 0 with small parts and greater as size and gage increase. Tolerances on pierced holes follow usual practice. Wherever possible hole diameters should be plus 0 and minus 0.010-inch or greater. Hole spacings should be plus 0.010-inch minus 0 or greater if possible, although in both cases extra care and cost will often permit somewhat closer limits.

Length tolerances on parts with formed ends should always be generous. Although plus or minus 0.015-inch can be held in some cases where parts are short and of light gage, specification of at least plus or minus 0.031-inch on small parts, 0.062-inch on medium parts and 0.125-inch on large parts will afford maximum economy and ease in handling. Naturally, tolerances for parts sheared to length prior to forming will depend upon the care and type of shear used, though here again wide tolerances are conducive to maximum economy.

Collaboration of the following organizations in the preparation of this article is acknowledged with much appreciation:

Cincinnati Shaper Co. ....
(*Figs.* 2, 3, 4, 6, 8, 9, 10, 11, and 13) .... Cincinnati
Verson Allsteel Press Co. (*Figs.* 1 and 5) .... Chicago
S. B. Whistler & Sons, Inc. (*Fig.* 12) .... Buffalo



Four-station, 5000-ton forming press manufactured by Birdsboro Steel Foundry and Machine Co. Hydraulic power provides uniform, adjustable speed over the full press stroke. Force applied is easily limited, and any dwell under pressure or desired length of stroke is controlled readily

Designing Hydraulic Circuits

By Ransom Tyler
The Oilgear Co.
Milwaukee

HOW TO DETERMINE if a design will do the job and what to expect from a hydraulic circuit are discussed in this abstract of a paper presented before the Machine Design Conference of the Cleveland Engineering Society. A convenient check list provides a methodical approach to evaluation of design

BEFORE designing a hydraulic circuit, it is important to consider alternative nonhydraulic methods of accomplishing the results desired, reviewing their possibilities as well as their limitations. After being assured that hydraulic methods have the greatest promise of fulfilling the requirements, it becomes necessary to choose which of the general systems of operation will probably be most suitable. The problem becomes one of determining sizes of units, details of the types of equipment and the exact number and arrangement of connections. Then it will become evident that the requirements can be compromised in some way to provide a simpler system, superior performance or reduced cost.

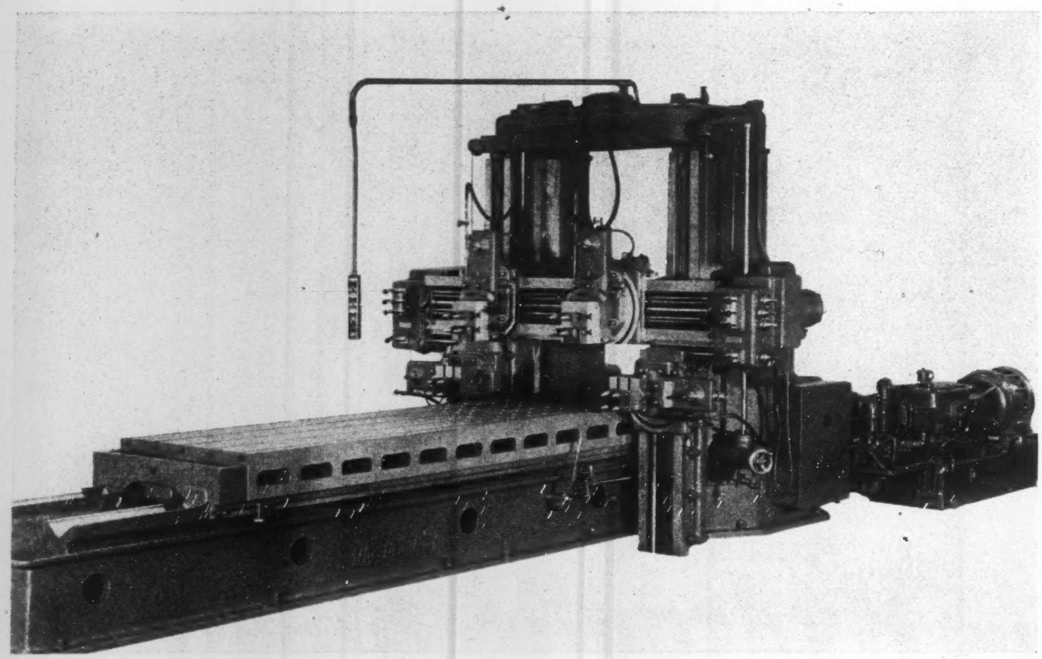
Actual process of designing a circuit is one of trial, check, and revision. There are few, if any, rules for procedure. Mechanical considerations largely determine the types of motors to select, the method of operating the controls, and other such details. Performance specifications dictate such things as pressure ranges best suited for operation and the complexity of the arrangements.

In planning the initial layout, it is often convenient to consider only the normal operation of the machine and to select units which best perform this operation. It is well to bear in mind that a wide range of hydraulic devices are considered standard and every effort should be made to utilize them. Time limitations should be carefully considered, as there is a tendency to forget that a fluid current has much more inertia than an electric current. To shut off or reverse the direction of fluid flow in the time an electric switch is flipped would often be unbearably noisy as well as destructive. Ample allowance must thus be made for time losses.

Elasticity is another factor which frequently is overlooked in the consideration of fluid-power circuits. This is a source of time loss. In addition, it builds a store of energy which, if released by too fast valving, will cause severe shocks. The importance of elasticity can be gaged roughly by the fact that hydraulic fluids, generally, have a bulk modulus of elasticity of about 1/100 that of steel. Since they are used frequently in a range of pressure or stress from a fourth to a third that of usual practice on mild steels, the springiness which might result can be appreciated.

These two factors, together with the leakage, have a great influence on selection of the pressure range. Low pressures lead to large units, high rate of flow and slow operation. Higher pressures lead to more flexibility or less rigidity, which might result in longitudinal or torsional vibration or chatter. Shock control also increases in difficulty as pressures increase, as more delicate control methods must be provided to control the small volumes through the large changes in pressure. The effect of leakage is well known; any given apparatus will leak or slip more at higher pressures. Thus, if leakage is a factor, a reduction in pressure, using the same equipment, is often a remedy for inadequate operation if the penalty of an overpowered machine can be paid.

In spite of the flexibility of hydraulic drives and of the great range of characteristics that can be encompassed in a single unit, there are limitations to maximum and minimum pressures, speeds and flow rates. Many specification writers have the careless habit of merely writing from zero to some hypothetical maximum figure. It is impossible to obtain a pressure control which will operate precisely at zero absolute, or even at zero gage. The same holds true for the other characteristics. The point chosen for the minimum operating point should be chosen carefully as operation under these minimum conditions is usually the most important and is, without question, the most difficult to obtain. However, this minimum is seldom given much consideration by specification writers who are not well acquainted with variable-speed units. They usually select a good round figure which, even though it might be a nice pressure at which to operate, is not practical for use in even extraordinary conditions.



Double-housing hydraulic planer built by Rockford Machine Tool Co. Hydraulic drive quickly and smoothly controls speed of the table

When a tentative scheme has been set out, it is necessary to check its operation both under normal and emergency operations and to make any necessary changes. While no complete list of check points is available, the accompanying table will indicate the scope of items to be considered.

It is not until these and similar questions can be answered in the affirmative that a fluid-power circuit may be considered to be fully designed. While this may sound like a tremendous effort, it is really no more than is required for any other mechanical design. The fact is that, when using a familiar design method, many checks are unconsciously applied while a new method requires close attention to every detail.

Hydraulic calculations are nothing but mechanics. Anyone who has learned his mechanics can do the computing necessary for a hydraulic circuit. The computations most frequently required are those which convert given specifications into a form suitable for selecting the required units. Such a calculation is required, for instance, to determine the size of press required to make a specified press fit, but it is in no way a hydraulic calculation. Yet it is often necessary in order to select the proper equipment.

Next in importance with respect to hydraulic systems are the calculations dealing with the selection of sizes of pipes, valves and passages to carry the fluid flow. These are hydraulic calculations, but their basis is hydrodynamics which is classed as a branch of mechanics. Undoubtedly many designers are not skilled in hydrodynamics but, fortunately, not much skill is required. There are charts, rating tables or nomograms available to assist in selecting the proper size of unit. It is only necessary to use reasonable discretion in establishing the permissible losses and to make sufficient allowance for changing viscosity of the fluid.

Check list for Facilitating Design of Hydraulic Circuits

Operation

- Will the system operate?
- Will it go through a required cycle without stalling or repeating, etc.?
- Is the sequence correct?
- Is it sufficiently interlocked?
- Is there a provision for return fluid where necessary?
- Is the pump suction adequate?
- Will air be cleared?
- Will the pipes drain out during idle periods causing a malfunction on starting?
- Is the unit protected against extremes of temperature?

Safety and Emergency Operation

- Can the unit be stopped instantly at any time?
- How is it started normally?
- Can it be damaged by starting after an emergency stop?
- How is it recycled?
- What "inching" functions are required?
- Will any element fall unexpectedly from lack of positive support?
- Will creeping take place when idle?
- What will happen if a fuse blows?
- Will it take care of itself if left unattended?

Appearance

- Does the equipment "fit" the job?
- Can it be arranged to produce a balanced, harmonious machine?
- Are connections and elements simple and can they be pleasantly arranged?

Performance

- Will the equipment do the job for which it is designed?
- Has it sufficient force, torque, speed range, etc.?
- Has sufficient allowance been made for lost time between valving and operation?
- Has proper allowance been made for off-standard operation, such as operation on 50 or 25-cycle current, or the use of standard gear ratios or sheave diameters rather than theoretical values?
- Has allowance been made for change in characteristics due to wear?
- Has allowance been made in the design for temperature change?
- Are all elements and connections of adequate size?

Maintenance

- Do the units chosen have the degree of dependability warranted by the importance of their work?
- Is their arrangement such that they are accessible for replacement or repair?
- Is the oil system protected by adequate filters, coolers, cleaners, breathers, or temperature cut outs?
- Is the oil reservoir provided with drainage facilities and a hand hole for cleaning?
- Can the oil level be checked conveniently?
- Is the equipment "fool proof"?
- Is it sturdy enough to stand the rough treatment which most industrial equipment sometimes gets?

Cost

- Is the overall cost, including installation, justified?

Third class of computations deals with establishing tolerances, setting limits, or selecting equipment to meet specific needs within required tolerances. Some discussion was given before of this point, and considerable reliance must be placed on the equipment manufacturers' statements as to performance in this respect.

Fourth class involves time and production figures. Strangely enough, this comes closest to involving hydraulic calculations. In many circuits the time required to store the energy required to stress the oil column is a factor. The elasticity or compressibility of oil is about 1/3 per cent for each 1000 psi, whether the oil is clear or solid. Most frequently, however, it is somewhat aerated, and this, combined with other strains in the containing members brings the factor to a higher value. Perhaps ½ per cent for each 1000 psi is a good average value to use. This affects timing because pumping is required to produce this stress. It also affects rigidity and can be used in determining the *K* factor.

Other calculations are, of course, required for designing hydraulic units. However they all belong in the fields of mechanics, mechanisms, or machine design.

In conclusion, a hydraulic power circuit is merely another mechanical element which has a few unfamiliar characteristics. Behavior of hydraulic elements must be studied to determine their performance in comparison with other power transmitting means. Favorable characteristics may be emphasized and the unfavorable ones minimized by proper selection of system, pressure range, type of control and size of equipment to produce performance most nearly matching the ideal. The particular characteristics which make hydraulic drives especially suited for many applications are their great flexibility, wide range, sturdy construction, and built-in protection against overload. When all of these factors can be purchased in a few standard packages and applied to a problem with only minor considerations compared to other transmission equipment, it is a method which can not be dismissed without serious consideration.

A New Approach to Design

A FUNDAMENTAL SYSTEM for developing any type of power-transfer mechanism by combining basic catalogued elements is presented in this article. In the July issue Mr. Ziebolz, inventor of the system, will discuss the application of his method to the development of hydraulic servomechanisms. A later article will treat pneumatic and electric followup units, showing how they may be designed by following the same procedure

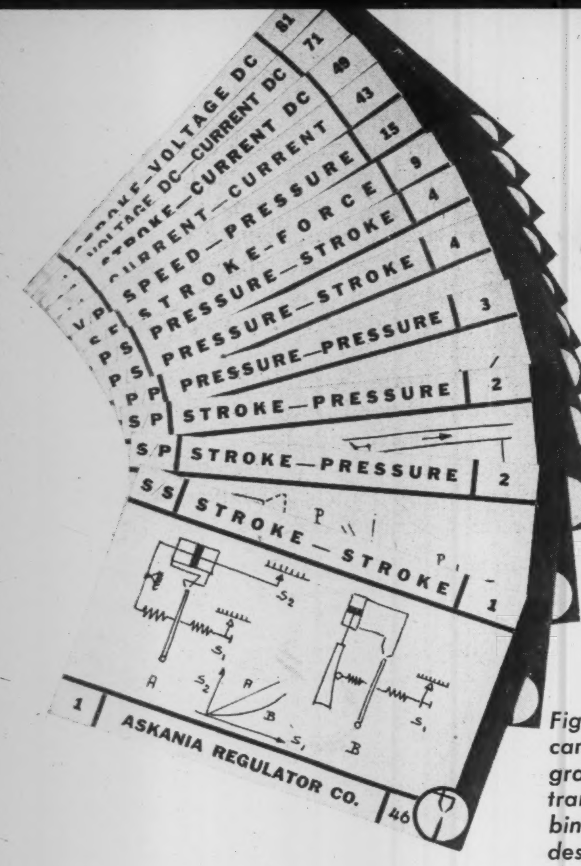


Fig. 1—Catalogued file cards, each carrying a diagram and data for a basic translator, may be combined readily to effect a design for any desired mechanism

A PROMISING new method of evolving versatile mechanisms and devices for the entire field of mechanical and electrical engineering has recently been outlined by H. Ziebolz, vice president and chief engineer of the Askania Regulator Co. Under the Ziebolz system all known devices used for the conversion of energy or power are being catalogued. Since there is only a limited number of types of energy, for example electric current and hydraulic pressure, there is likewise only a limited number of basic types of power converters, or "translators". Using the Ziebolz index, it is possible to select the most desirable mechanisms with great rapidity. In addition, it is easy to place together chains of translators to obtain results which are, for all practical purposes, inventions.

Using this system, the design of any device or machine will consist of three steps. First, the translators are selected from a master chart and organized in the proper sequence. Then file cards, *Fig.* 1, each carrying the complete description of one type of translator device, are chosen by reference numbers on the chart. With this information, the design consists of selecting the one translator of a given type which will do the job best and then combining it with the others selected.

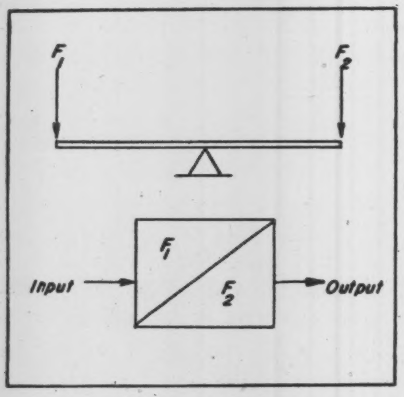


Fig. 2—Lever is a translator since it converts force F_1 to force F_2. Method of representing this translator is shown by box. Input is always at left, output always at right

To simplify the representation and discussion of devices such as translators, block diagrams have already been widely used. Under the new plan a similar symbol, used in much the same manner as a chemical equation, is applied. A typical example is shown in *Fig.* 2. Here is represented a simple lever system. In this instance a force applied at the one end of the arm results in a proportional force at the other end. The schematic way of representing this translator is below the sketch. The input, F_1 is represented always in the left side of the box, while the output, F_2 is at the right.

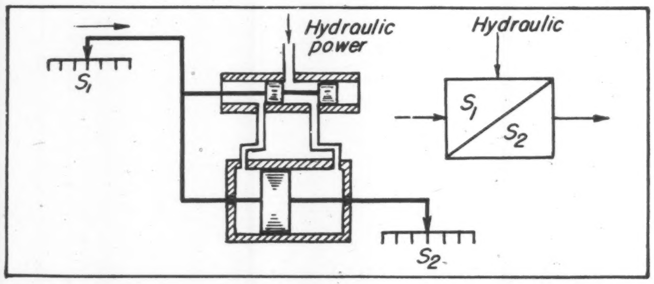


Fig. 3—Second type of translator has only one step or link, but uses auxiliary power. Servo uses hydraulic force multiplication while keeping proportional stroke

In instances where additional power is required, it may be shown as a vertical arrow drawn to the top of the translator box as in *Fig.* 3. This is a type of mechanical servo-mechanism in which the augmenting power is hydraulic. A motion of the input lever results in a proportional motion of the output lever. The proportionality, however, is entirely independent of the power supplied and depends on the length of the lever arms as in *Fig.* 2.

Two or more translators may conveniently be placed in series as shown in *Fig.* 4. In this example there is represented a piston pump direct-connected to a Bourdon type gage. It is apparent that if the plunger of the pump is depressed, the resulting chain of actions causes needle deflection. Considering the device as a translator chain, the motion of the plunger or stroke, *S*, is the input to the system and is so represented at the left of the left-hand box. The first energy translation consists of changing this plunger stroke into a pressure change, *P*, within the pump. This entire change is represented in the first box. The next translation to take place is the conversion of hydraulic pressure in the system to motion of the gage needle. In this case the change is, of course, from pressure *P* to stroke S. The two translators may be combined into one, as indicated in the right-hand box. This reduction in the chain is indicated in the final translator by a short line through the diagonal. The technique of extending or compressing translators in the manner just illustrated is one of the most valuable characteristics of the system, for it is the clue to the application of the translator system to design.

While the box type of symbol is convenient for use in sketching out mechanisms it suffers from unwieldiness in either printed or verbal form. Therefore, it has been modified for general use by the elimination of the box and the representation shown in *Fig.* 6 substituted. The way the symbol is read takes advantage of the similarity of the written symbol to algebraic fractions, and the use of the exponent for indicating power may be excused since it is easy to remember, although it may appear as a pun.

Discussion so far has only considered such variables as pressure *P* and motion or stroke S. There are, of course, many others which are in everyday use. Examples may include the vacuum tube in which a change in grid voltage, *e* results in a change in plate current, *i*, or the centrifugal governor which, having as an input a rotational

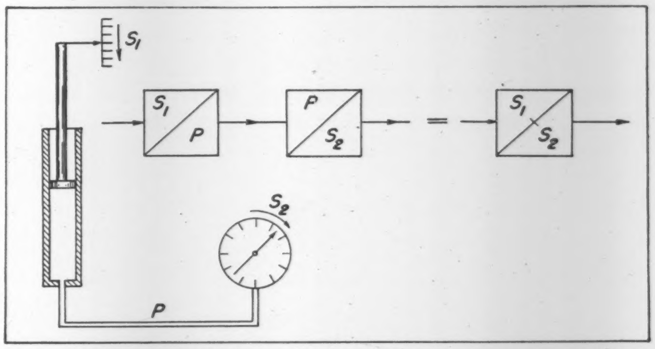
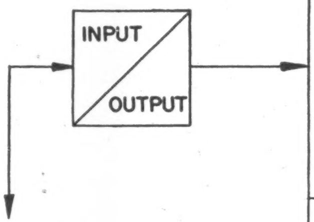


Fig. 4—Above—Third type of translator uses no auxiliary power but has two links in the power chain. System above translates piston stroke S_1 to hydraulic pressure P. In Bourdon gage, pressure is translated into pointer stroke, S_2

Fig. 5—Translator map. This makes provision for conversion of any input to any output by the use of devices designated by block numbers

		STROKE (OR ANGLE α)	PRESSURE	FORCE	$\frac{ds}{dt}$ SPEED (OR $\frac{d\alpha}{dt}$)	$\frac{d^2s}{dt^2}$ ACCEL. (OR $\frac{d^2\alpha}{dt^2}$)	RATE OF FLOW	CURRENT D. C.	CURRENT A. C.	VOLTAGE D. C.	VOLTAGE A. C.	TEMPERATURE	LIGHT INTENSITY	RESISTANCE	INDUCTANCE	CAPACITANCE	PHASE ANGLE	MAGNETIC FIELD	ELECTROSTATIC FIELD	FREQUENCY	
		S	P	F	V	α	W	i	$\underset{\sim}{i}$	e	$\underset{\sim}{e}$	T	Q	R	L	C	φ	H	E	f	
STROKE (OR ANGLE α)	S	1	2	9	10	25	26	49	50	81	82	121	122	169	170	225	226	289	290	361	
PRESSURE	P	4	3	8	11	24	27	48	51	80	83	120	123	168	171	224	227	288	291	360	
FORCE	F	5	6	7	12	23	28	47	52	79	84	119	124	167	172	223	228	287	292	359	
$\frac{ds}{dt}$ SPEED ($\frac{ds}{dt}$ OR $\frac{d\alpha}{dt}$)	V	16	15	14	13	22	29	46	53	78	85	118	125	166	173	222	229	286	293	358	
$\frac{d^2s}{dt^2}$ ACCEL. (OR $\frac{d^2\alpha}{dt^2}$)	α	17	18	19	20	21	30	45	54	77	86	117	126	165	174	221	230	285	294	357	
RATE OF FLOW	W	36	35	34	33	32	31	44	55	76	87	116	127	164	175	220	231	284	295	356	
CURRENT D. C	i	37	38	39	40	41	42	43	56	75	88	115	128	163	176	219	232	283	296	355	
CURRENT A. C.	$\underset{\sim}{i}$	64	63	62	61	60	59	58	57	74	89	114	129	162	177	218	233	282	297	354	
VOLTAGE D. C.	e	65	66	67	68	69	70	71	72	73	90	113	130	161	178	217	234	281	298	353	
VOLTAGE A.C.	$\underset{\sim}{e}$	100	99	98	97	96	95	94	93	92	91	112	131	160	179	216	235	280	299	352	
TEMPERATURE	T	101	102	103	104	105	106	107	108	109	110	111	132	159	180	215	236	279	300	351	
LIGHT INTENSITY	Q	144	143	142	141	140	139	138	137	136	135	134	133	158	181	214	237	278	301	350	
RESISTANCE	R	145	146	147	148	149	150	151	152	153	154	155	156	157	182	213	238	277	302	349	
INDUCTANCE	L	196	195	194	193	192	191	190	189	188	187	186	185	184	183	212	239	276	303	348	
CAPACITANCE	C	197	198	199	200	201	202	203	204	205	206	207	208	209	210	211	240	275	304	347	
PHASE ANGLE	φ	256	255	254	253	252	251	250	249	248	247	246	245	244	243	242	241	274	305	346	
MAGNETIC FIELD	H	257	258	259	260	261	262	263	264	265	266	267	268	269	270	271	272	273	306	345	
ELECTROSTATIC FIELD	E	324	323	322	321	320	319	318	317	316	315	314	313	312	311	310	309	308	307	344	
FREQUENCY	f	325	326	327	328	329	330	331	332	333	334	335	336	337	338	339	340	341	342	343	

velocity, *V*, produces a position change, *S*. The former is an (e/i) translator, while the latter is a (V/S) type. Other types of variables which are included in the development so far are shown in the left-hand column of *Fig.* 5.

Inasmuch as any of the variables may be used as the input or the output of a translator or translator chain it is possible to compile a table or "map", assigning a definite position to each translator device. The result is a field of boxes, *Fig.* 5 each occupied by a translator and designated by a number for simple reference and identification. The column on the left represents the input and the line at the top represents the output of each translator.

Studying this map it may be noted that there is a definite significance attached to certain types of translator columns. The first column of numbers, for instance, has all of the variables as inputs and a common output stroke. These translators can, therefore, be represented by the term variable/stroke. As the term stroke is meant to be used in its broadest sense, devices of this type may be broadly classified as instruments.

On the other hand, the first horizontal line of numbers starts with the common input S, and has various variables as outputs. It is, therefore, a stroke/variable type. Most manual and automatic knob or pointer setting devices as well as controls fall into this group which may be broadly classified as regulators. The important implication of the use of the first column and the top line is that, if it can be shown that translators are available for the boxes which they contain, all the rest of the map is also covered.

It may be assumed, for example, that a translator, type 29, is needed. This is a device which produces a change in flow as the result of a change in speed. Such a device might be used for providing cooling water for a combustion engine, where it is usually desirable that a definite proportionality exist between the speed input and the amount of flow. Since there is available translator 16, a speed indicator V/S, this may be added to translator 26, S/w, producing translator 29, a V/w type.

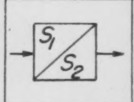
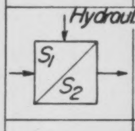
Symbol	Written	Read
	$\left(S_1/S_2\right)$	"S_1 over S_2 translator"
	$\left(S_1/S_2\right)^{\text{Hyd}}$	"S_1 over S_2 translator with hydraulic power"

Fig. 6—Three methods of representing translators

In general, then, it may be said that a chain of two translators of the left vertical column and top horizontal line covers completely the field of the map since any translator on the map may be reached without leaving these two groups of translators.

Simpler and more direct solutions are available in most of the boxes and the foregoing approach does not eliminate the desirability of filing their characteristics under the respective number of the map. However, certain classes shown on the map have yet to be developed. An example of this is a device for converting a pure electrical input voltage or current into a definite resistance or capacitance. Fortunately, the technique illustrated obviates, for the time being at least, these devices.

If a stroke/variable type translator is combined with its inversion, the variable/stroke translator, a particularly useful type of device, the servomechanism, is produced. This stroke/stroke translator may be said to cover servomechanisms in the broadest meaning of the term for it includes devices from the simplest lever to a radio-controlled valve on a ship or aircraft. Since the intermediate variable can be anything from electricity to sound, the possible solutions are very numerous, especially since it is not necessary to restrict the translator chain to two links.

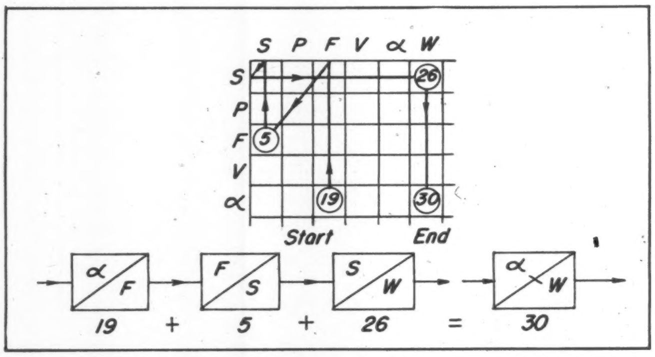


Fig. 7—Method of developing machine using the translator map. Acceleration input to block 19 is translated by chain into a flow output in block 30

In *Fig.* 7 such a translator chain is developed using three links. Starting in the center of the map this example in which a flow control device is to be actuated by acceleration illustrates the operation of this useful chart. Starting with the a/F translator (19), it may be observed that a F/S translator (5) and the translator S/w (26) are available. As an example, (19) may be a mass, translating acceleration *a* into force *F*. This, applied to a spring scale (5) will produce a stroke *S* which may be used to control a flow-rate regulator (26) resulting in a change in flow *w*. The result is then:

$$a/f + F/S + S/w = a/w$$
$$19 + 5 + 26 = 30$$

There has thus been developed with ease a new device.

The method or path to get from (19) to (30) is of interest. As indicated in *Fig.* 7, translator (19) changes the initial acceleration into force, but leaves the map in the top-horizontal column, the purely output portion of the map. As indicated by the arrows on the figure, the next step is to transfer the position to the analogous position on the input column, that is to translator (5). Further translations are followed in similar step-wise fashion.

Each translator is illustrated schematically with supporting data on a file card and classified according to the map or master chart. Thus, as new translators are designed, a "library" of translators is formed from which may be developed any new combination of translators to perform a specific function. As the library grows its usefulness becomes more universal, thus relieving the designer of the task of recreating basic elements each time he is confronted with a design problem.

TOO MANY SOCIETIES

Chief engineers and designers of machines who feel justifiable pride in their profession usually hold membership in one or more of the national engineering societies. That they cannot take part in the activities, or enjoy the benefits, of more than an extremely small percentage, is clearly evident from the fact that there are approximately a hundred national organizations devoted to the various branches of engineering and the numerous phases of each. Adding to the number, and to the confusion, more and more societies are being formed to cater to the specialized needs of relatively few engineers who feel their requirements are not being met by the organizations already established.

Such a situation leaves not only the individual engineer, but also the engineering societies as a whole, in a much weaker position than would be the case if greater co-ordination between the societies could be achieved. Overlapping of responsibilities and conflict of activities are bound to occur. Already the "competition" between engineering organizations is given as the reason higher caliber meetings are not held, with resulting decrease in attendance and slackening of enthusiasm on the part of the individual member.

That the need for, and the tendency toward, co-ordination of engineering societies are recognized is apparent from the fact that in Great Britain the Institution of Mechanical Engineers and the Institution of Automobile Engineers recently have become amalgamated as a single unit. Considerable work also is being done in this country in the attempt to bring the numerous societies closer together. One of the primary objectives, for instance, of the Engineers Joint Council—a group comprised of representatives of the five "founder" societies— is a "comprehensive study of the needs of engineers for a national form of organization that will more properly serve the engineering profession". It is to be hoped rapid progress will be made and a plan effected whereby not only the technical but the economic status of the engineer may be greatly enhanced.

Much credit is due the various technical councils, local engineering societies and other similar bodies in bringing together engineers and co-ordinating their activities. If such collaboration, aided by the Engineers Joint Council, could be broadened to the point of becoming national—or even international—in scope, the whole profession would be in a much stronger position to carry out its responsibilities and to reap the benefits of its achievements.

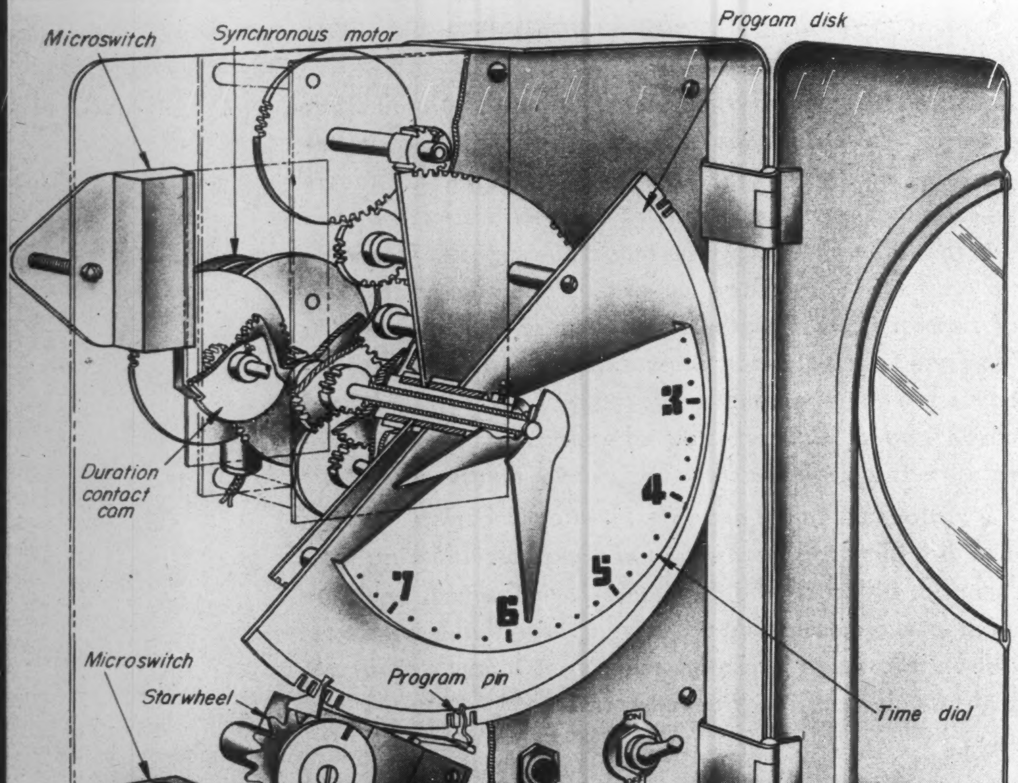
L. E. Jermy

DESIGNS OF THE MONTH

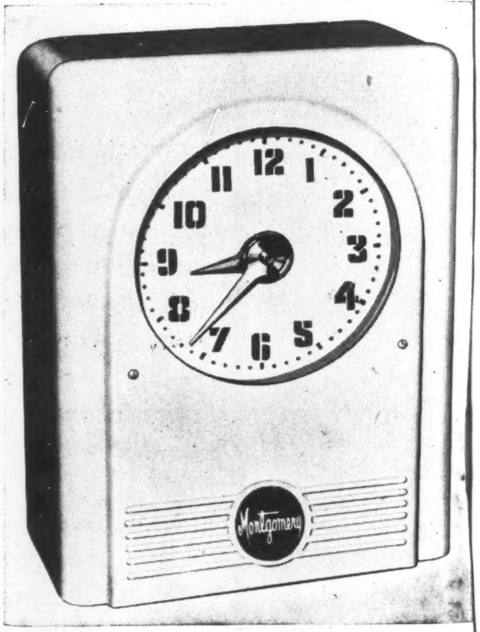
Clock Hands Set Schedules in Program Clock

THIS synchronous program clock is designed to control equipment automatically in accordance with a preselected time schedule. A conventional time dial facilitates clock settings. The program mechanism is directly connected with the time movement and dial, being automatically adjusted when the clock hands are set. Programing is effected by mechanical operation of contacts at definite times and for definite lengths of time. First set of contacts (program contacts) is operated by clips attached to the edge of a 7-inch diameter program disk, divided into 5-minute intervals or 288 divisions, which rotates once every 24 hours. These contacts are adjusted to operate approximately 2 minutes prior to the time indicated on the disk and to remain in operation approximately 2 minutes after the time indicated.

Second set of contacts (duration contacts) is operated from a cam having a circumferential speed of 0.0065-inch per second. A saw-tooth notch provides a positive starting time for the operation of the contacts and permits an adjustment of operation duration by varying the point on the incline at which the contacts are returned to normal. Thus, the first set of contacts provides a rough preselection of the operating time and the second set, being actuated by a cam having high circumferential speed, gives the precise operating and duration time. Duration adjustment is accomplished by flexing the jackplate on which the duration contacts are mounted so as to vary the distance between the contact actuator and cam.



CUTAWAY VIEW OF PROGRAM CLOCK

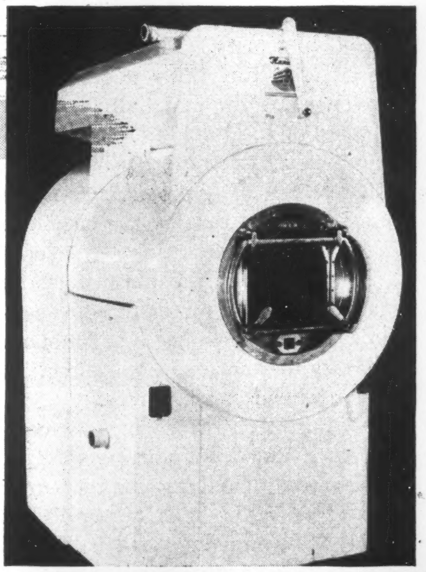


Since many schedules do not repeat each day of the week and 12-hour schedules usually are not repeated at night, an automatic calendar switch for omitting operation during these times is included. This is accomplished by a third set of contacts (automatic switch contacts) in series with the other two mentioned and operated at 12 to

24-hour intervals depending upon the maximum schedule duration of the program clock. Operation of the automatic switch contacts is accomplished by having a special lug on the program disk engage a starwheel connected with the automatic switch dial. This dial carries program pins in slots corresponding to the days or half-days of the week.

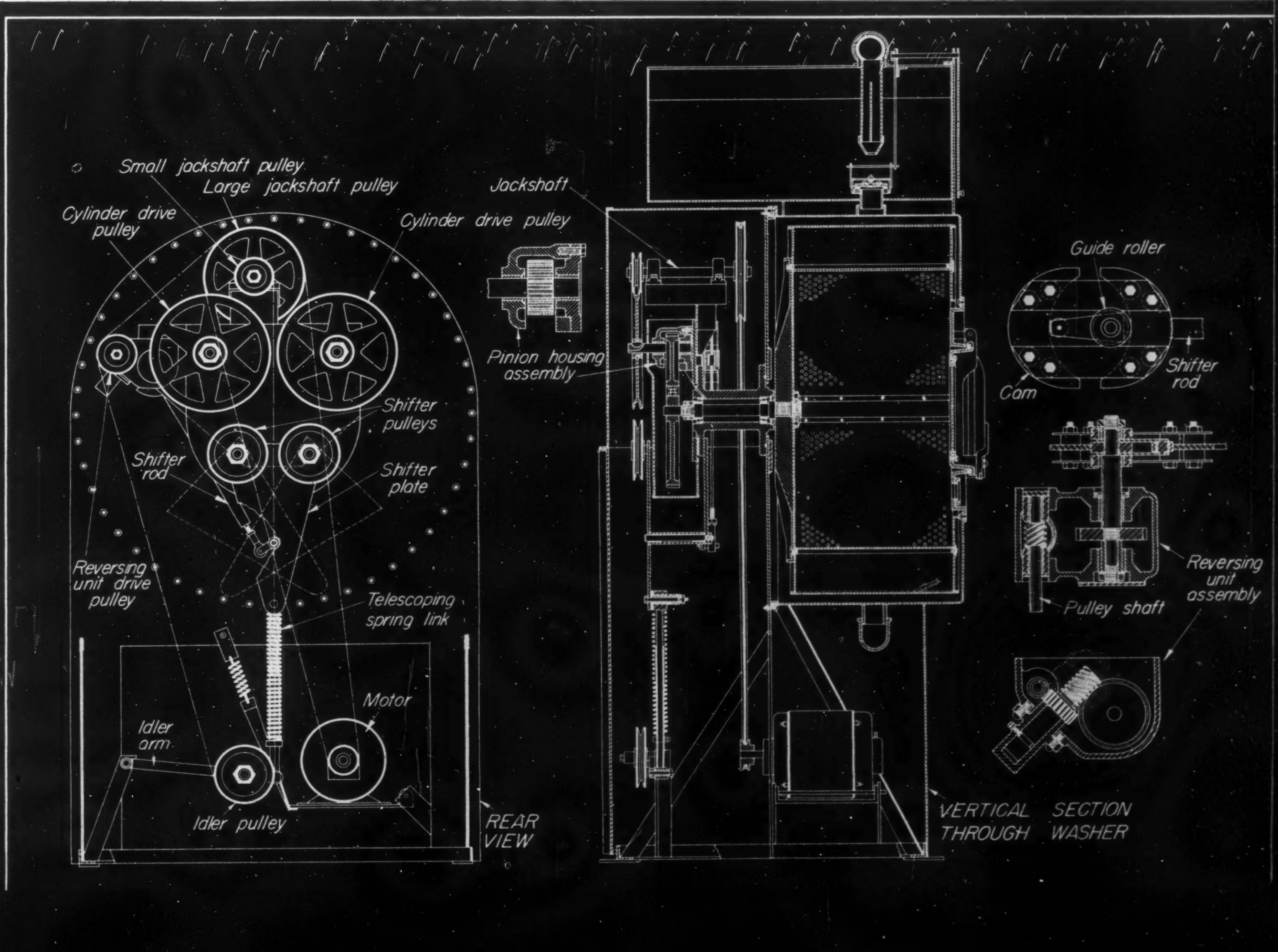
In addition to the clock-operated contacts described, a manual switch is connected in series with the load circuit so that automatic operation can be omitted during holidays, vacations, etc. Also, a pushbutton is connected in parallel with the load terminals so that manual operation is possible at any time for emergency use, special schedule or test. Manufacturer: Montgomery Mfg. Co., Chicago 6.

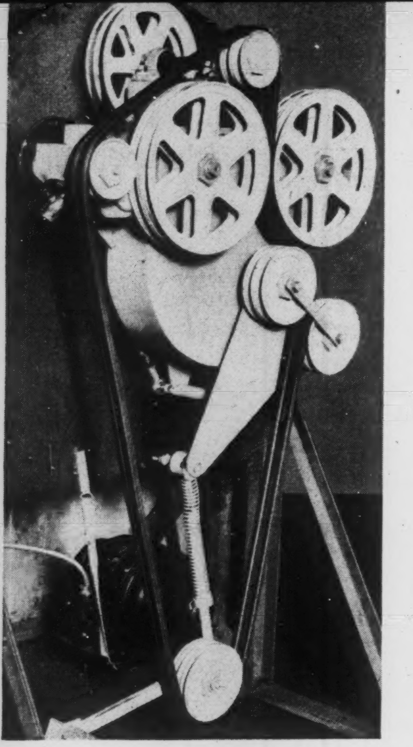
Commercial Washer Employs Novel V-Belt Reversing Mechanism



THIS open-end washing machine built for the laundry and drycleaning trade, features a newly developed reversing drive. The drive, as shown in the drawing, below, is from the motor at the base of the machine by V-belt to the large jackshaft pulley, thence from the small jackshaft pulley by double-sided V-belt over the idler pulley at the base and the reversing-unit drive pulley. The double-sided V-belt passes between the two cylinder-drive pulleys and also between the two shifter pulleys. Thus, by throwing the shifter plate to right or left, either one or the other of the cylinder-drive pulleys will be driven. Pinions mounted on the drive-pulley shafts mesh with a spur gear on the wash-cylinder shaft.

Reversal of cylinder rotation is effected through the double-worm reduction unit shown in the separate sectional views on the drawing. Output shaft of this unit drives a short arm at the end of which is a roller which rides on the inner face of a two-piece plate cam. As the arm rotates, action of the roller on the cam reciprocates the shifter rod, the opposite


Small jackshaft pulley
Large jackshaft pulley
Cylinder drive pulley
Cylinder drive pulley
Shifter pulleys
Shifter rod
Shifter plate
Reversing unit drive pulley
Telescoping spring link
Motor
Idler arm
Idler pulley
REAR VIEW
Jackshaft
Pinion housing assembly
VERTICAL SECTION THROUGH WASHER
Guide roller
Cam
Shifter rod
Reversing unit assembly
Pulley shaft



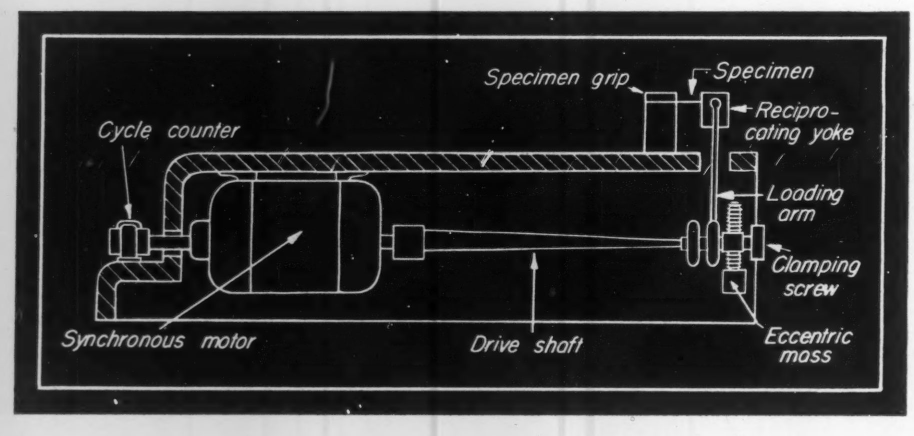
end of which pushes or pulls on the end of a crank fastened to the shifter-plate shaft. Thus, as the shifter plate is thrown alternately to right and left, the double-sided V-belts drive the right and left cylinder-drive pulleys alternately too. The machine is timed to reverse approximately every 14 seconds. The telescoping spring link connecting the shifter plate to the idler arm end serves two purposes. First, it maintains constant belt tension during the reversing period, and second, the compressed spring compensates for belt wear and stretch throughout the life of the belts. Manufacturer: Hammond Laundry-Cleaning Machinery Co., Waco, Texas.

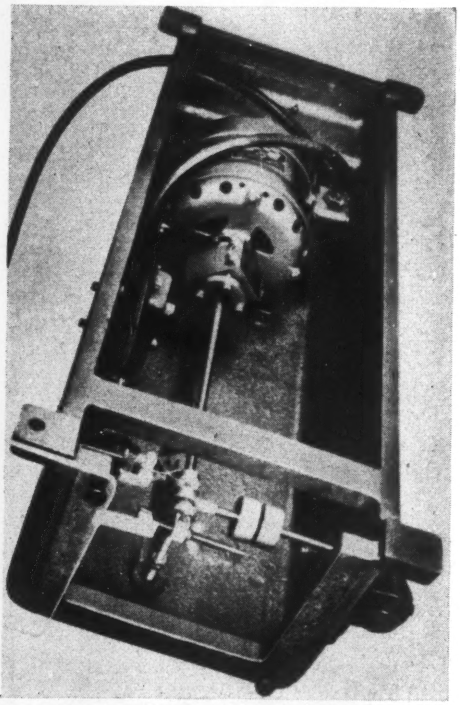
Constant-Force Fatigue Testing Machine

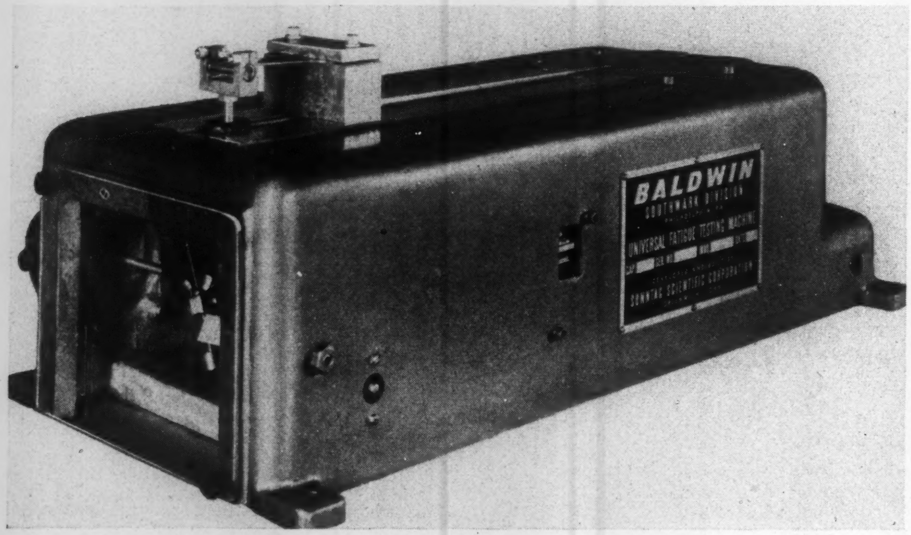
IN THIS machine for fatigue testing sheet materials in flexure, a harmonic force is produced by an eccentrically-mounted revolving mass. This force is applied to the free end of the specimen by a loading yoke carrying a needle bearing pivot. The yoke is linked to the motor-driven shaft through ball bearings. Movement is so constrained that vertical components of the force are transmitted precisely to the loading yoke, and horizontal components are absorbed.

Since the revolving eccentric is the exclusive source of force excitation, the force may be adjusted by loosening the clamping screw and moving the eccentric mass in or out. Magnitude of the alternating force is indicated on a scale calibrated in "pounds-force". Of necessity, rotational speed of the mass must be constant. This is accomplished by employing a synchronous motor directly connected to the mass by means of the driveshaft which, acting as a cantilever spring, also functions as an inertia force compensator. As the centrifugal force accelerates the masses in one direction, the spring reacts in the other by an amount exactly equal to the sum of the inertia forces.

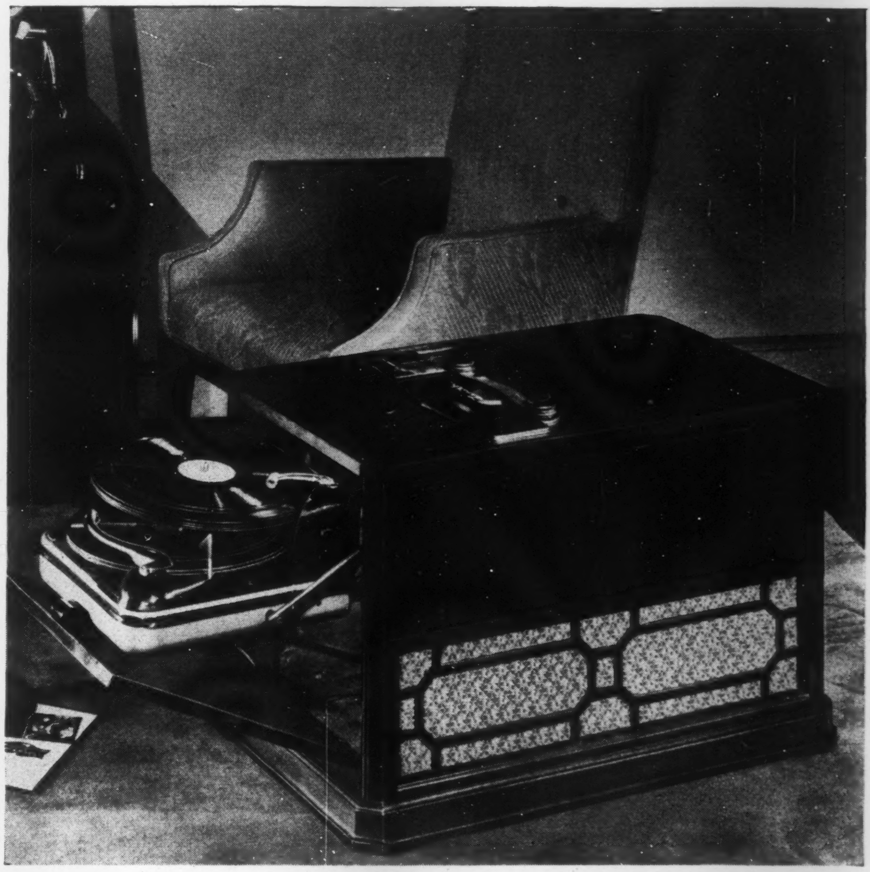
Adjustment necessary to compensate for changing weight of specimens, auxiliary loading arms or other fixtures, is accomplished simply by moving small calibrated weights along the rod which restrains the moving mass horizontally. Mfr: The Baldwin Locomotive Works, Philadelphia 42.





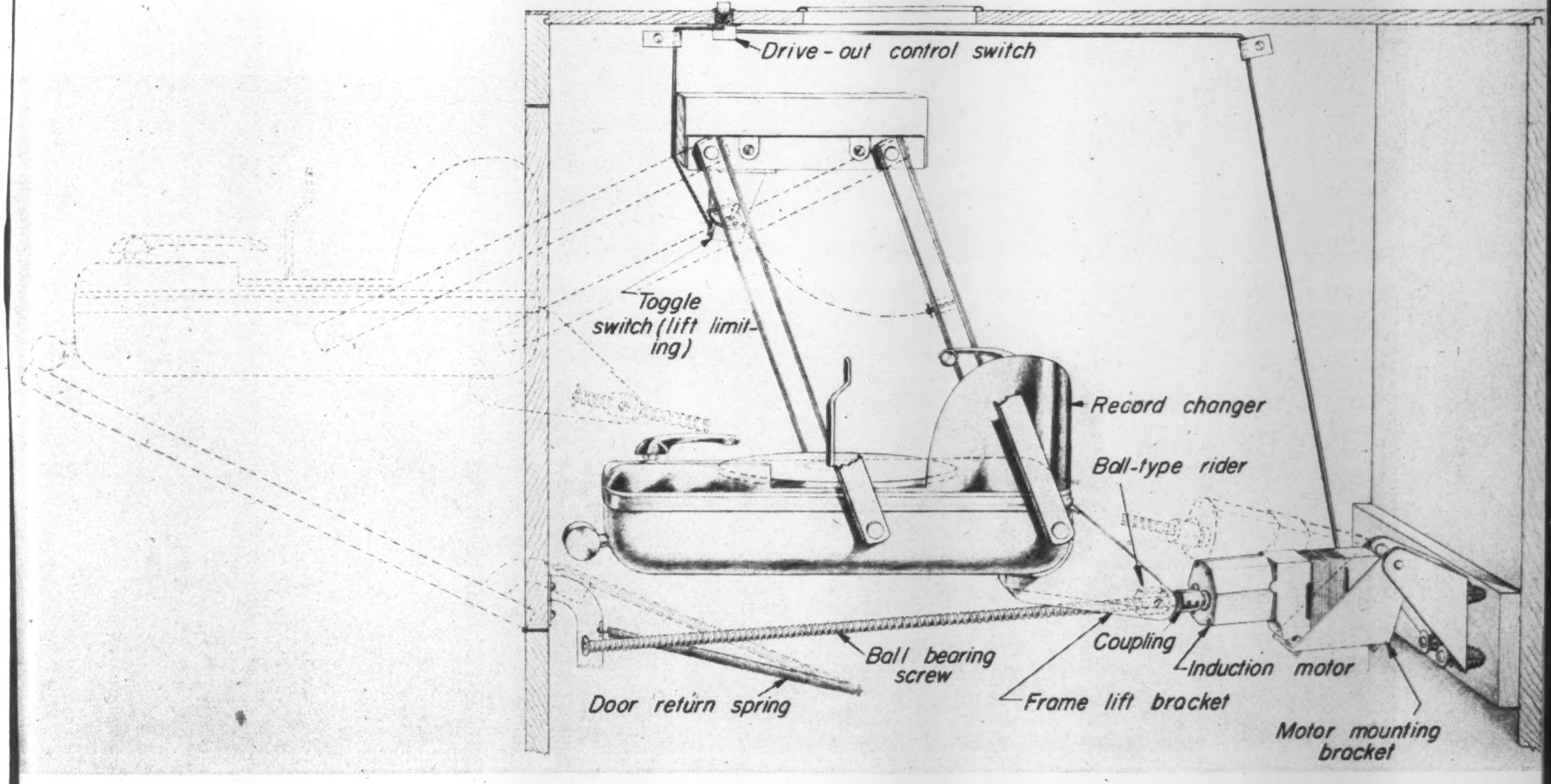

BALDWIN
SOUTHWARK DIVISION
UNIVERSAL FATIGUE TESTING MACHINE
SONNTAG SCIENTIFIC CORPORATION

Combination Radio Has Disappearing Automatic Phonograph



CONTROLLED by a single pushbutton located on the top of the cabinet, phonograph unit of this combination radio-phonograph is swung out of cabinet into a position where records can be loaded or unloaded easily. Mounted on arms of channel cross-section which are arranged in parallelogram fashion, the phonograph is propelled forward and up by an induction-motor-driven ball bearing power screw which engages a nut or rider in which a series of balls circulate. This ball-bearing action of the rider on the screw maintains drive friction at a minimum. The motor is reversible and brought to a stop by a toggle type limit switch which is actuated by one of the parallelogram arms. In its "out" position the unit tends to freewheel downward, hence a brake is provided to hold it.

Both the drive unit and rider are rubber mounted to prevent disturbances in the performance of the radio. Cabinet door, through which the phonograph unit emerges, is hinged downward and spring loaded for self-


Drive-out control switch
Toggle switch (lift limiting)
Record changer
Ball-type rider
Coupling
Induction motor
Ball bearing screw
Door return spring
Frame lift bracket
Motor mounting bracket

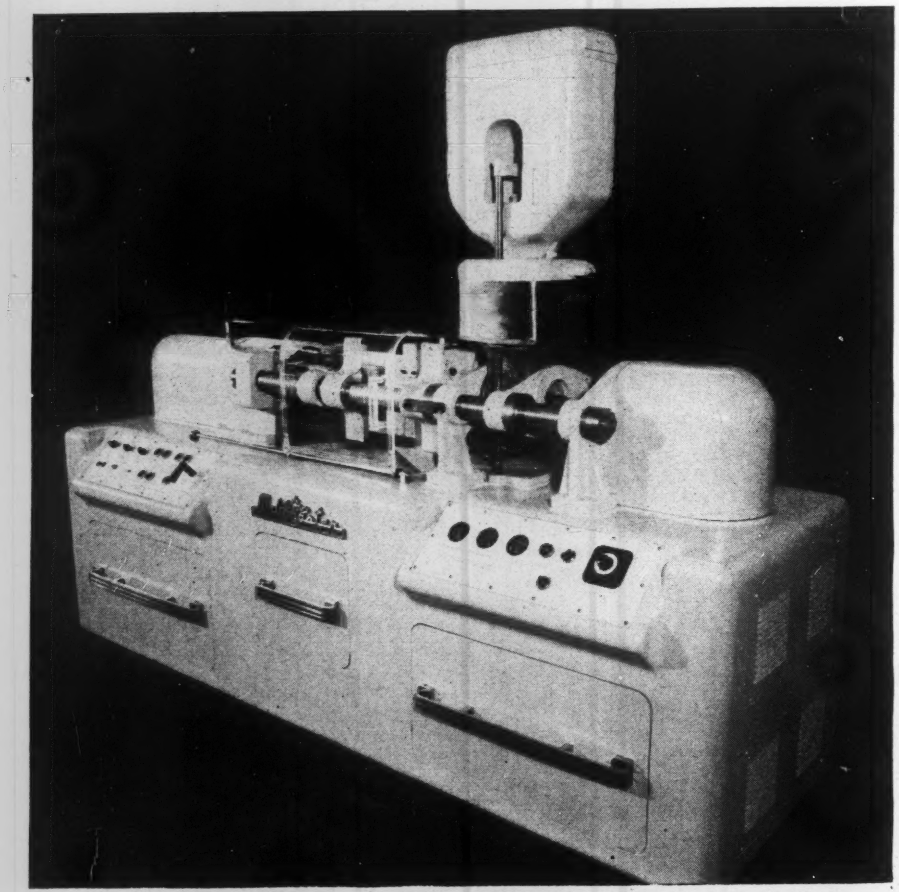
closing. The phonograph can operate in both the "in" and "out" positions as well as on its way up or down. For convenience, all controls are located on the top of the cabinet. Mfr: Zenith Radio Corp., Chicago 39.

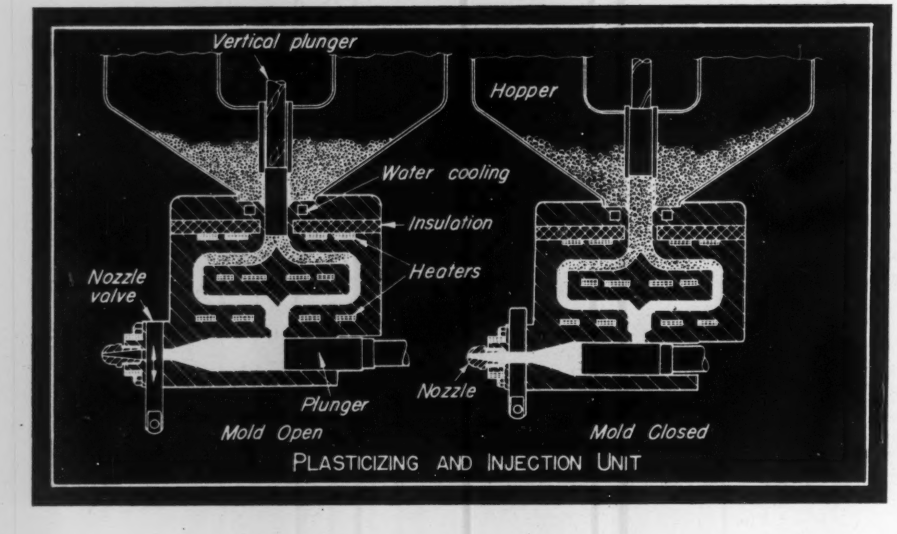
Plastics Injection Molder

INTERESTING toggle arrangement, pictured in the drawing (lower right) is used for locking the molds in this injection molding machine. In this mechanism, which is hydraulically actuated, the thrust arms and thrust plate are cast steel, while the links, eccentrics and pins are cold-rolled steel, case hardened and ground for high wear-resistance.

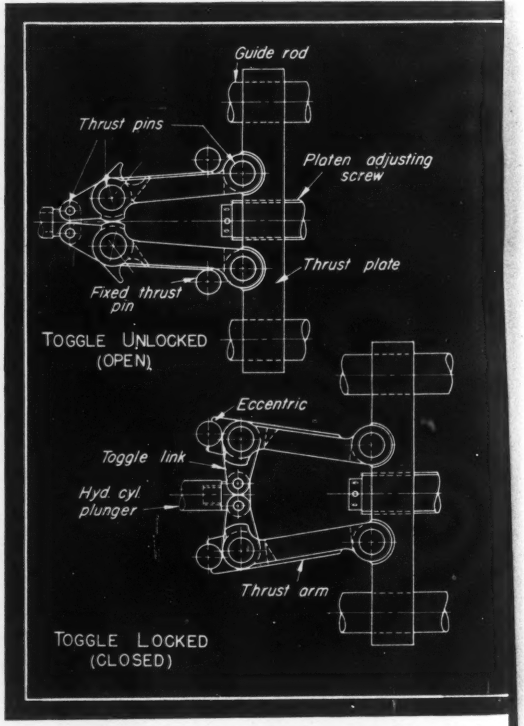
Machine has been designed to handle the injection molding of all thermoplastics at comparatively low pressures and high rate of feed. Contained within the nickel-bearing cast iron main housing are the hydraulic oil tank, pumps, the necessary control valves and oil lines, the electronic timers and the electric relay panel. Direct-mounted on the rear of the cabinet is the electric motor drive. Also on the back of the cabinet is the junction box for connecting thermocouple and power lines to the temperature controller which is wall-mounted away from the machine proper.

As is shown in the accompanying schematic (lower left) the plastic granules are forced from the hopper into the plasticizing unit by a hydraulically operated plunger. The plasticizing unit is mild steel with internal surfaces chrome plated, and heat is supplied by electric heating rings. Injection plunger, cylinder and valve are Hastelloy metal. Tie bars are chrome-moly steel, hardened and ground. Manufacturer: Crown Machine and Tool Co., Fort Worth 7, Texas.



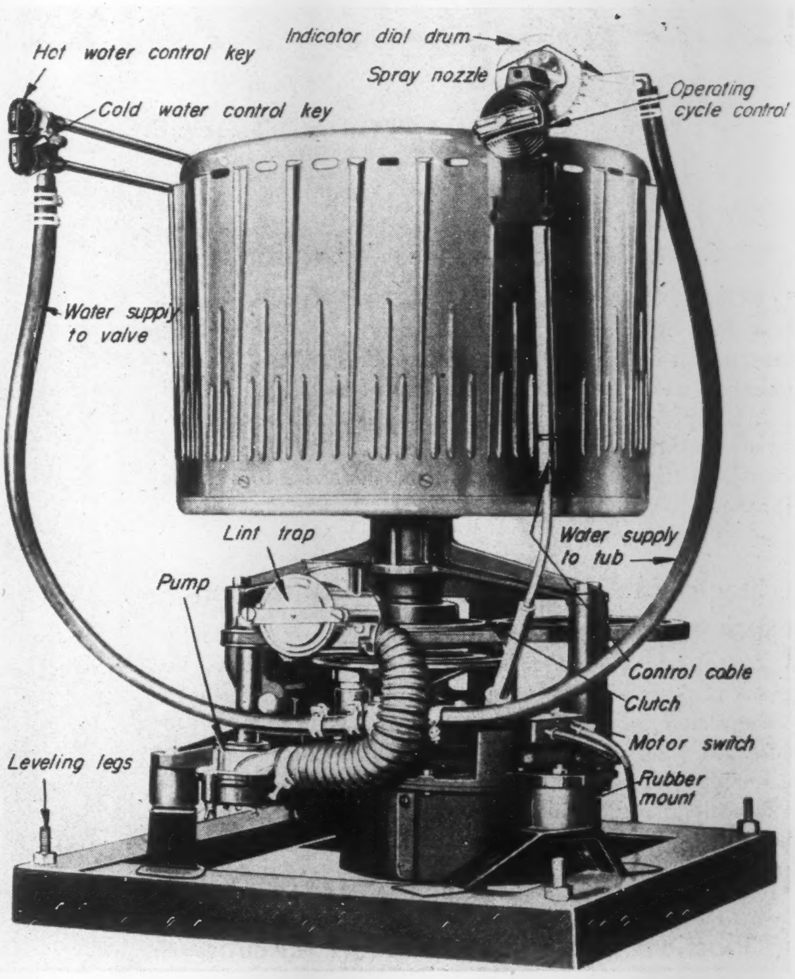

Vertical plunger
Hopper
Water cooling
Insulation
Heaters
Nozzle valve
Plunger
Nozzle
Mold Open
Mold Closed

PLASTICIZING AND INJECTION UNIT

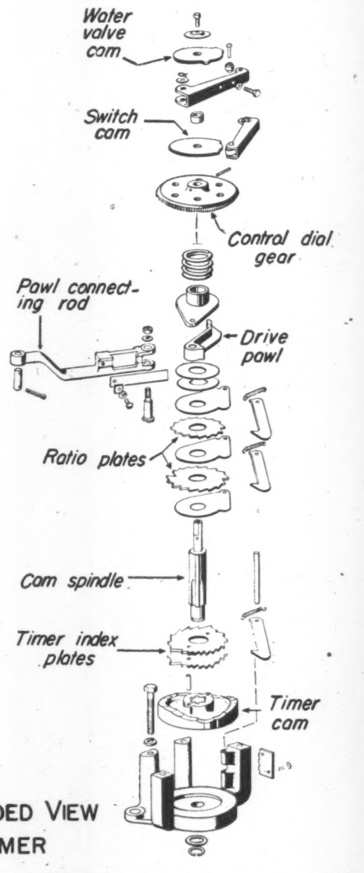

Guide rod
Thrust pins
Platen adjusting screw
Thrust plate
Fixed thrust pin
TOGGLE UNLOCKED (OPEN)
Eccentric
Toggle link
Hyd. cyl. plunger
Thrust arm
TOGGLE LOCKED (CLOSED)

Automatic Washer Has All-Mechanical Controls

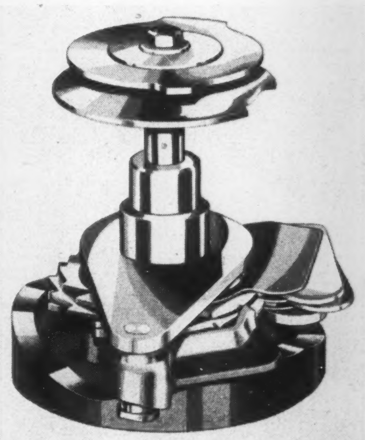
THIS automatic washer utilizes the agitator washing principle and affords automatic cycling of washing, rinsing and damp drying operations. All functions are controlled by mechanical means, there being no solenoids, thermostats, float valves, etc., involved. The gearcase houses the main gear driving mechanism and the mechanical timer (see drawing, below) which is actuated by a connecting rod which reciprocates the drive pawl of the timer. Drive to spinner, agitator and pump is by V-belt from a ¼-hp capacitor motor. The timer utilizes three toothed ratchet plates and, when the deep-cut teeth in the first and second plates line up, the drive pawl drops into a tooth in the timer index plate, pushing this plate and the attached timer cam forward one step to actuate the next cycle of operation. At the top of the timer shaft are two additional cams, one of which operates the motor switch and the other the water-control valve.

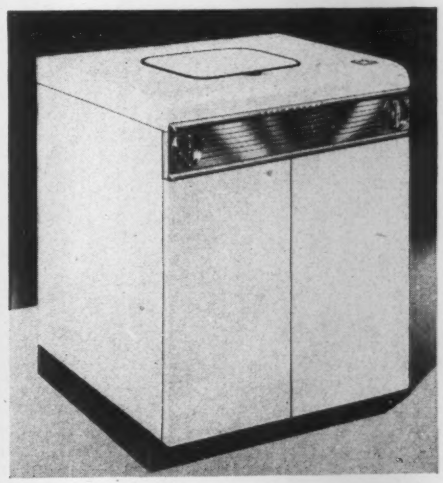

Hot water control key
Indicator dial drum
Spray nozzle
Cold water control key
Operating cycle control
Water supply to valve
Lint trap
Water supply to tub
Pump
Control cable
Clutch
Motor switch
Leveling legs
Rubber mount

By means of its contoured surface of varying elevations, the main drive cam actuates a rocker arm through a roller, which in turn raises and lowers the agitator shaft and also the spinner shaft which connects to the tub. Operating-cycle control on the front of the machine functions through a flexible shaft at the end of which is a bevel pinion which meshes with the control-dial gear. This control advances the timing from "stop" to "fill", and sets the length of time of the wash period. Tub of the machine consists of a hot-galvanized bottom, stainless-steel sides and top ring, and a cast-aluminum centerpost. Manufacturer: Blackstone Corp., Jamestown, N. Y.


Water valve cam
Switch cam
Control dial gear
Pawl connecting rod
Drive pawl
Ratio plates
Cam spindle
Timer index plates
Timer cam

EXPLODED VIEW OF TIMER


ASSEMBLY OF MECHANICAL TIMER

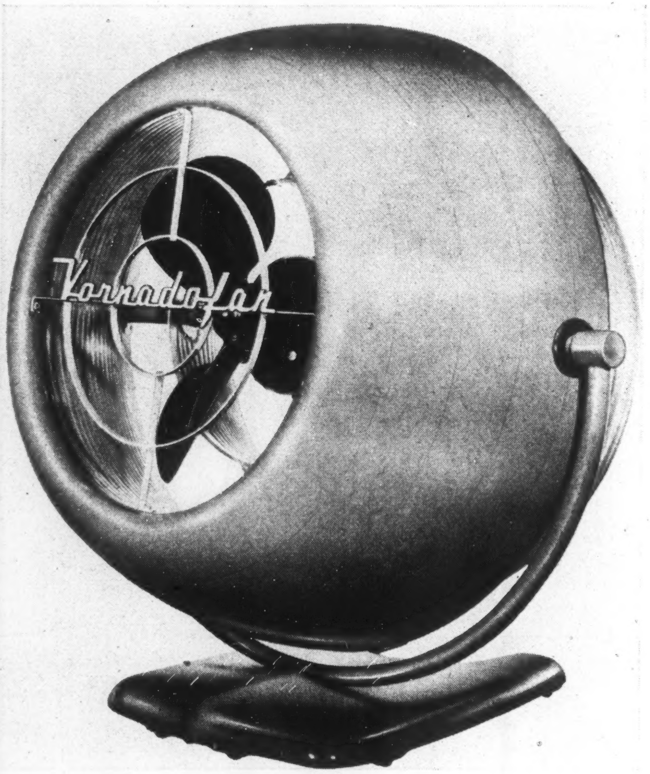


Applications

of engineering parts, materials and processes

Spun Shroud Reduces Vibration

HUM AND VIBRATIONAL noises of the Vornado-fan, right, are largely eliminated by the spun-metal construction of the two air-directing cones. These intake cones are made of a continuous strip of metal interlocked as it is "spun" into its venturi-like shape. The cone, being discontinuous in section, can not act as a sounding board and thus does not transmit mechanical into audible vibrations.

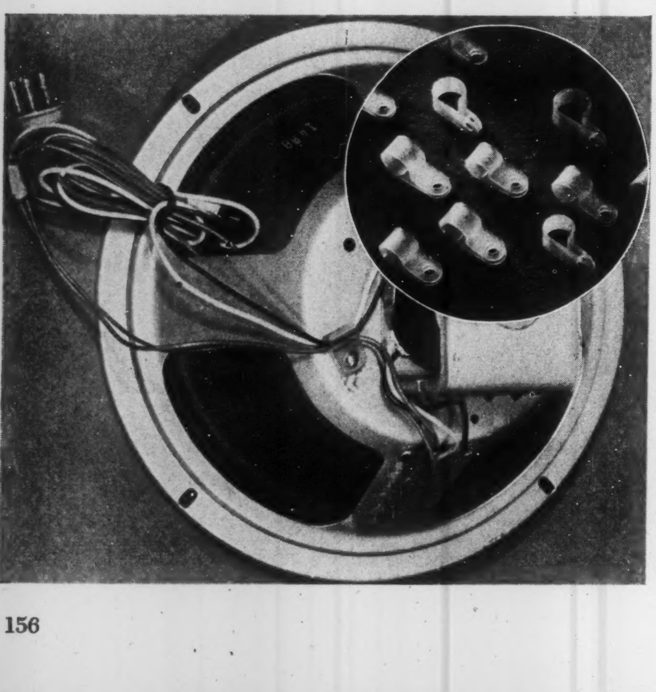


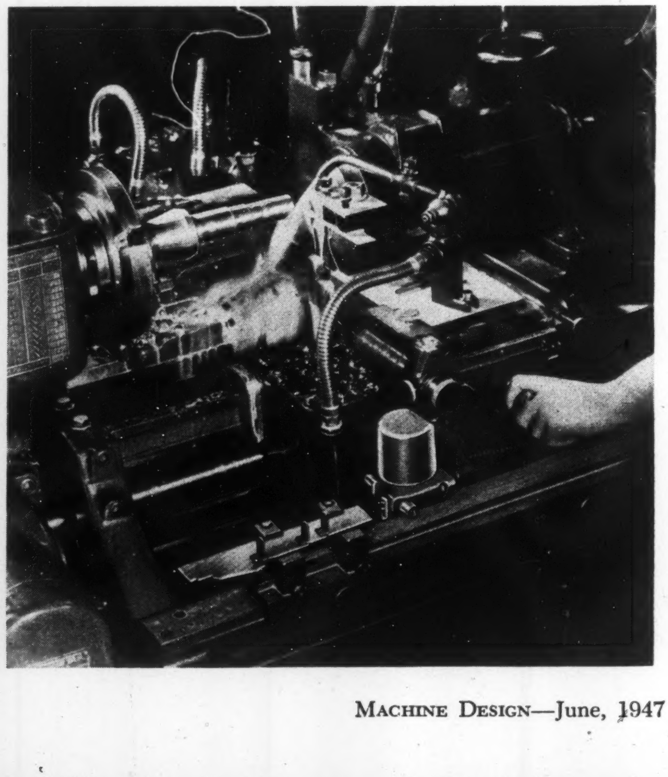
Electrical Switches Control Contouring

PROFILE DIMENSIONS of machined parts are closely controlled on the Monarch lathe, right below, by means of Micro-Switches actuated by templates fastened to the machine bed. Switches in can, right foreground of illustration, are operated by fingers which ride along template, seen just to left of switch can. Magnetic clutches in lathe regulate longitudinal and cross-feed motion of cutting tools. Rate of feed is controlled by cams on upper face of template.

Plastic Clips Eliminate Short Circuits

ELECTRIC WIRES for the radio speaker, below, are fastened to the frame with clips of Dow Ethocel. Being plastic, the clips are noncorrosive, electrically nonconductive, strong, lightweight and resistant to acids, alkalies and oils.





Vibration-Isolating Bases

Based on a recent ASME paper, this data sheet presents formulas and charts for design of spring suspension systems with controlled natural frequencies in all modes of vibration

By Charles E. Crede* and J. Paul Walsh*

L. N. Barry Co. Inc.
Cambridge, Mass.

ISOLATION of rotating or reciprocating machinery to reduce the magnitude of oscillating forces transmitted to adjacent structures is common practice. This data sheet presents the technique used at the Naval Research Laboratory for mounting vibration-testing machines, in which forces to be isolated are of great magnitude and speed range is wide. The method is generally applicable to the design of machinery bases and will be found to be of particular value in cases where low-speed machines are involved.

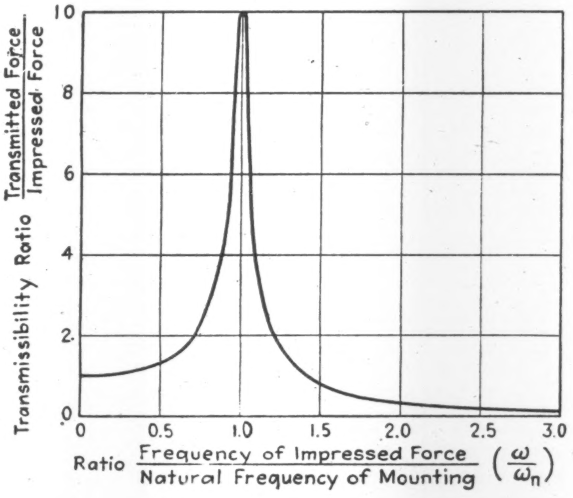
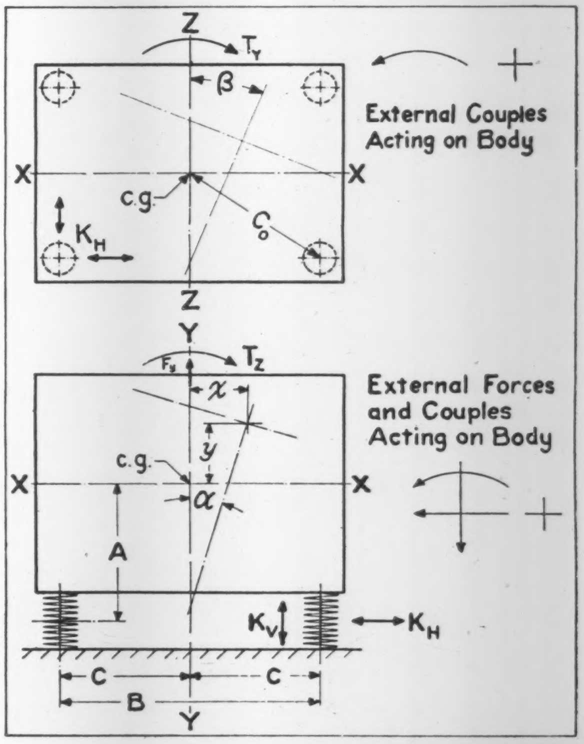


Fig. 1—Transmissibility of vibration-isolating system

Transmissibility or percentage of impressed force transmitted to the foundation may be determined from the conventional curve (1)† shown in *Fig.* 1. The transmitted forces become high unless the natural frequency of the mounting is substantially less than the frequency of the force impressed by operation of the machine. This applies to the natural frequency in any mode of vibration likely to be excited by an impressed force of appreciable magnitude. The problem is thus resolved into one of controlling the natural frequencies of the mounted machine. For high-speed machines, it generally will be satisfactory to have a substantial difference among the several natural frequencies, provided the highest is not above the predetermined allowable maximum. For low-speed machines, isolation conditions place an upper limit on allowable natural frequencies and stability conditions set a corresponding lower limit. The upper and lower limits are frequently very close together; the mounting system therefore must have all natural frequencies substantially equal.

The natural frequency in a vertical direction of a body mounted on springs, *Fig.* 2, may be determined (2) from the following equation (see Nomenclature):

Fig. 2—Forces and couples acting on machine and base


Z
T_Y
β
External Couples Acting on Body
+
X
X
c.g.
C_o
K_H
Z
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F_Y
T_Z
x
y
c.g.
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X
X
External Forces and Couples Acting on Body
+
A
K_V
K_H
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C
B
Y

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* Formerly of the Naval Research Laboratory, Shock and Vibration section, Washington, D. C.

† Numbers in parentheses refer to references listed at end of data sheet.

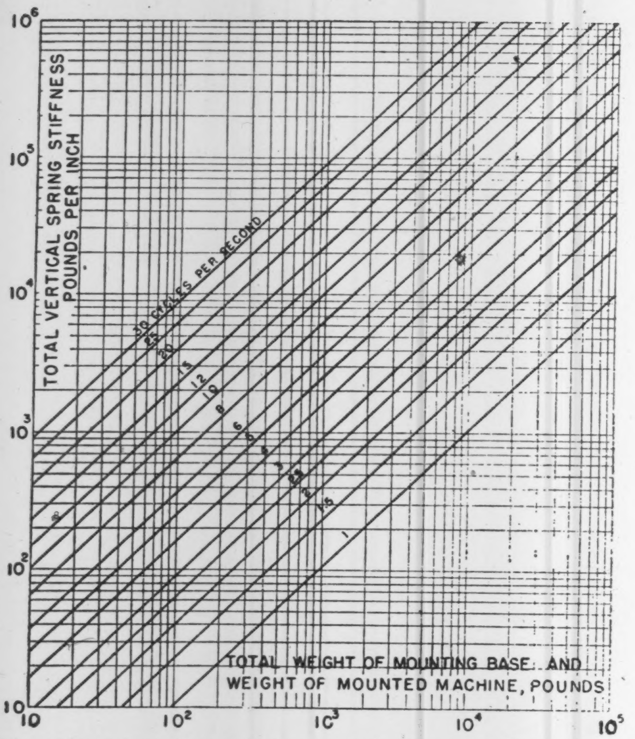
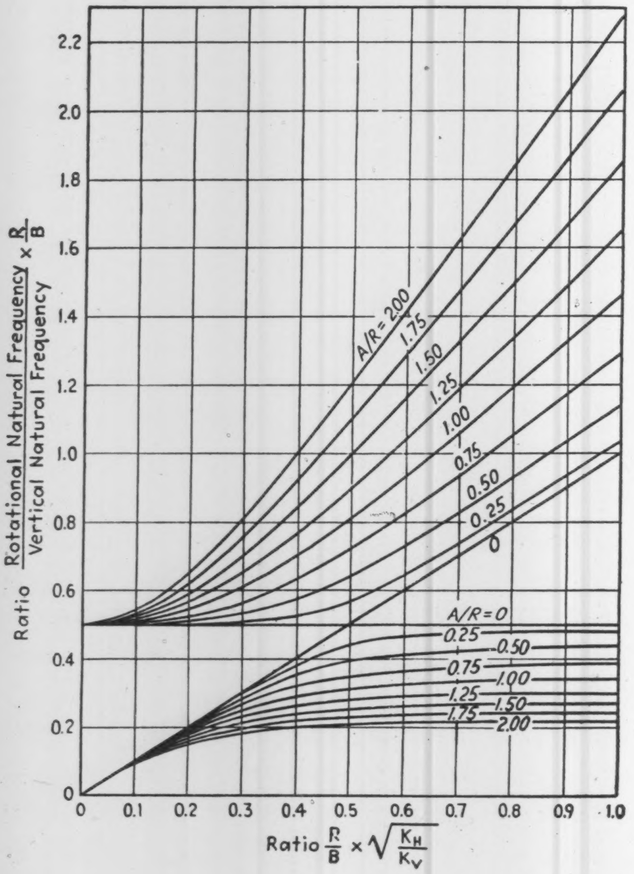


Fig. 3—Above—Vertical natural frequency of mounting system in terms of total vertical spring stiffness and total weight of mounting base and mounted machine

Fig. 4—Below—Relationship between vertical and rotational natural frequencies of spring-supported machine



$$\omega_v = \sqrt{\frac{4K_v}{M}}; \quad f_v = \frac{1}{2\pi}\sqrt{\frac{4K_v}{M}} \quad \ldots\ldots (1)$$

The natural frequency in rotation about the vertical Y-axis is given by:

$$\omega_y = C_o\sqrt{\frac{4K_h}{MR_y{}^2}}; \quad f_y = \frac{C_o}{2\pi R_y}\sqrt{\frac{4K_h}{M}} \quad \ldots\ldots (2)$$

In a similar manner, natural frequencies for motions in

Nomenclature

W = Total weight of assembled machine and mounting base, lb
M = Total mass of assembled machine and mounting base, lb sec^2/in.
I = Mass moment of inertia of assembled machine and mounting base, lb-in. sec^2 (subscript denotes axis of rotation)
K_v = Stiffness of a single helical spring in vertical direction, lb per in.
K_h = Stiffness in a horizontal direction of a single helical spring with restrained ends, lb per in.
K_h' = Horizontal spring stiffness, neglecting vertical load, lb per in.
T_z = Torque on body about Z axis, in.-lb
T_y = Torque on body about Y axis, in.-lb
R_y = Radius of gyration of assembled machine and mounting base with respect to Y axis, in.
R_z = Radius of gyration of assembled machine and mounting base with respect to Z axis, in.
B = Horizontal distance between springs, in.
C_o = Horizontal distance from springs to center of gravity of mounted assembly, in.
A = Vertical distance from midpoint of spring to center of gravity of assembled machine and mounting base, in.
N = Ratio of horizontal to vertical spring stiffness = K_h/K_v
ω = Frequency, radians per sec
ω_v = Vertical natural frequency, radians per sec
f_v = Vertical natural frequency, cycles per sec
ω_y = Natural frequency about vertical axis, radians per sec
f_y = Natural frequency about vertical axis, cycles per sec
G = Modulus of elasticity of steel in torsion $= 11.5 \times 10^6$ psi
d = Spring wire diameter, in.
r = Mean coil radius of helical spring, in.
D = Mean coil diameter of helical spring, in.
h = Working height of helical spring, in.
n = Number of active turns in helical spring
P = Vertical load on helical spring, lb
δ_1 = Static deflection of helical spring due to weight of mounting base and machine, in.
g = Acceleration of gravity $= 386$ in. per sec^2
L = Length of links in suspension system, in.

---

a vertical plane and having horizontal components may be determined from the following:

$$\frac{\omega}{\omega_v}\,\frac{R_z}{B} = \pm\frac{1}{2}\sqrt{\frac{NR_z{}^2}{B^2}\left(\frac{A^2}{R_z{}^2}+1\right)+\frac{1}{4}\pm\sqrt{\left[\frac{NR_z{}^2}{B^2}\left(\frac{A^2}{R_z{}^2}+1\right)+\frac{1}{4}\right]^2-\frac{NR_z{}^2}{B^2}}} \quad \ldots (3)$$

The relation given in Equation 3 expresses the two other natural frequencies in the XY-plane as a function of the vertical natural frequency. For convenience, the vertical natural frequency is shown graphically in *Fig.* 3, as determined from Equation 1, and employing the usual engineering units; the rotational natural frequencies, as defined by the two numerically different roots of Equation 3, are shown graphically in *Fig.* 4. It is evident from an inspection of *Fig.* 4 that the design objective of equal natural frequencies may be attained by employing springs having equal horizontal and vertical stiffnesses ($K_h/K_v = 1$) spaced apart a distance equal to twice the radius of gyration ($R_z/B = 1/2$) and supporting the mounted machine in a horizontal plane through its center of gravity ($A/R = 0$). In general, the rotational natural frequencies differ from the vertical natural frequency and may be determined by reference to *Fig.* 4. The corresponding natural frequencies in the YZ-plane may be determined by analogy.

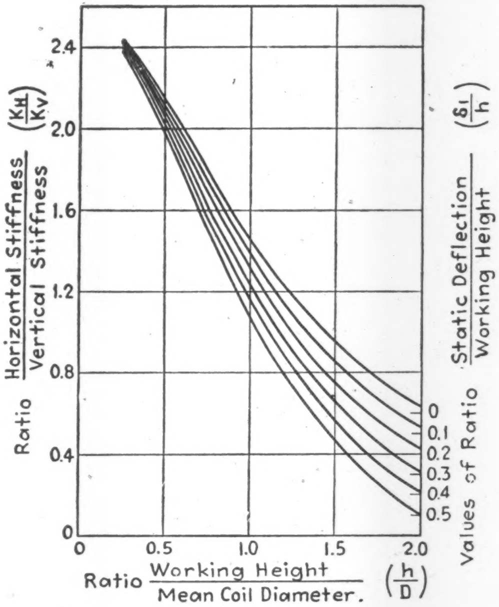


Fig. 5—Relation between vertical and horizontal stiffnesses for helical spring

In order to use *Figs.* 3 and 4, it is necessary to know the vertical and horizontal stiffness of the helical supporting springs. The approximate equation (3) for the vertical deflection of a helical spring is

$$\delta_v = \frac{64Pr^3n}{Gd^4} \quad \ldots\ldots (4)$$

This equation is well known and has been made conveniently useful in the form of nomographs, slide rules, and tables.

Information on the horizontal stiffness of helical springs is not so plentiful. Recent analytical and experimental work (4) has established the validity, within a certain degree of accuracy, of the following equation for stiffness ratio:

$$\frac{K_v}{K_h'} = 1.44\left(0.271+0.206\frac{h^2}{D^2}\right) \quad \ldots\ldots (5)$$

ENGINEERING DATA SHEET

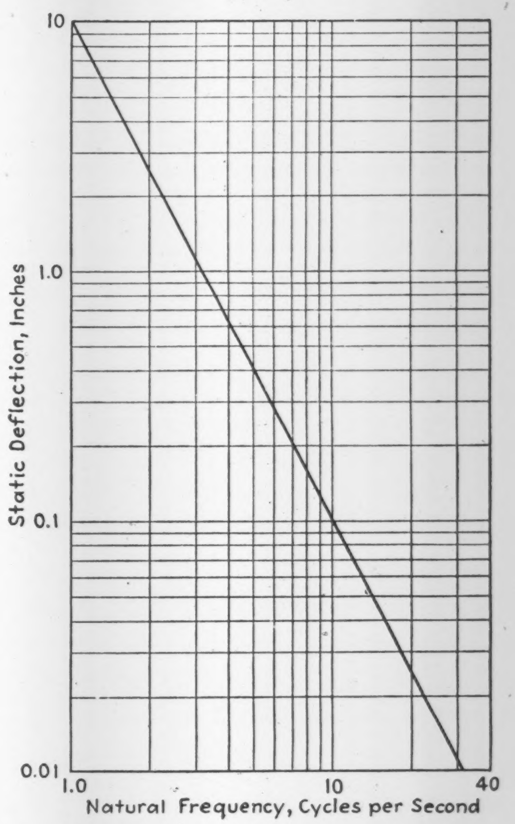


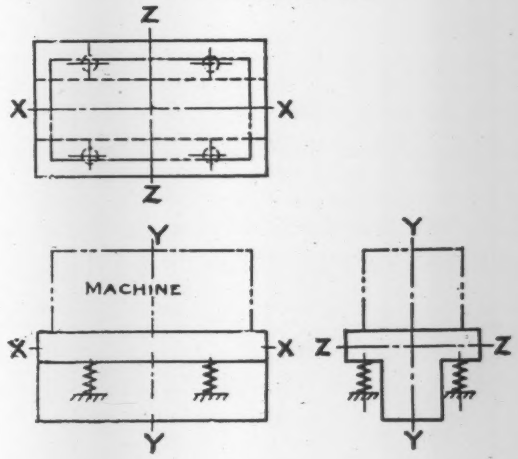
Fig. 6—Chart for calculating natural frequency in terms of static deflection

Equation 5 neglects the effect of vertical load upon horizontal stiffness. It was pointed out by Wahl (5) that the vertical load lowers the horizontal stiffness by a factor α, a function of h/D and δ_1/h. Equation 5 may then be modified as follows:

$$\frac{K_v}{K_h} = 1.44\alpha\left(0.271+0.206\frac{h^2}{D^2}\right) \quad \ldots\ldots (6)$$

Fig. 5 is a graphical presentation of Equation 6 and pro-

Fig. 7—Design of Mounting base for a vibration-testing machine



ENGINEERING DATA SHEET

vides a useful means of determining the horizontal stiffness of helical springs.

One of the parameters in *Fig.* 5 is the ratio of static deflection to working height of spring. The static deflection may be determined from Equation 1 by substituting $M = W/g$:

$$f_v = \frac{1}{2\pi}\sqrt{\frac{4K_v g}{W}} = 3.13\sqrt{\frac{1}{\delta_1}} \qquad \text{........................ (7)}$$

Equation 7 is shown graphically in *Fig.* 6.

Stability of a system in which the mounted machine rests upon helical springs and is restrained from horizontal movement only by the horizontal stiffness of the springs also should be investigated. A condition of stable equilibrium exists when a system is in a condition of minimum potential energy (6).

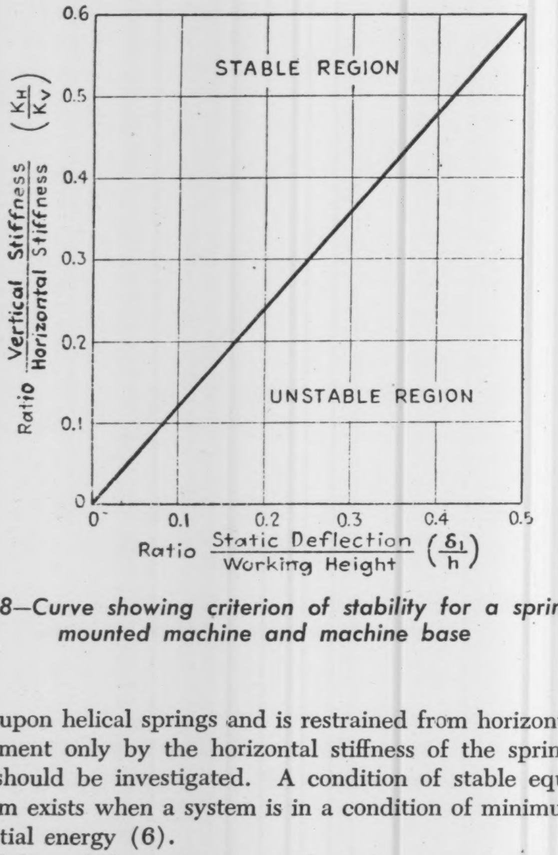


Fig. 8—Curve showing criterion of stability for a spring-mounted machine and machine base

Stability of the spring-mounted machine can be investigated, then, by writing the equation for change of potential energy and noting the conditions for which the energy increases and decreases as horizontal movement of the mounting base takes place. As the mounting base is deflected horizontally, its elevation is lowered, due partly to bending of the spring axis and partly to the decreased vertical spring stiffness resulting from the eccentric vertical load. This loss of potential energy must be balanced by an increase in strain energy in the spring due to horizontal deflection and to increased vertical deflection caused by eccentricity of loading. Assuming constant horizontal spring stiffness, the boundary between the stable and unstable regions is given by

$$\frac{K_h}{K_v} = 1.20\left(\frac{\delta_1}{h}\right) \qquad \text{................................. (8)}$$

This equation is shown graphically in *Fig.* 8.

Buckling of the springs as columns, in contrast to instability in sidesway discussed in the foregoing, should be considered. However, springs of the type used in applications described herein are loaded far below their critical loads.

A pendulum-type suspension as shown in *Fig.* 9 is sometimes used for isolating machinery. The lateral stiffness of the spring is of small consequence in such a suspension because the horizontal restoring force is due principally to the weight of the mounting base when deflected laterally from its equilibrium position. *Fig.* 4 may be used for computing rotational natural frequencies by taking the abscissa scale as $(R/B)\sqrt{W/4LK_v}$.

The pendulum-type suspension generally will be found inferior to the arrangement shown in *Fig.* 7 for installations in which it is desired to maintain all natural frequencies approximately equal to an established maximum. One of the rotational natural frequencies in the vertical plane of the dimension B_1 in *Fig.* 9 will be substantially larger than the vertical natural frequency because the distance B_1 between springs usually will be much greater than twice the radius of gyration R of the mounting base. The other rotational natural frequency in this plane and both rotational natural frequencies in the vertical plane of the dimension B_2 can be adjusted within wide limits by varying the length L of the supporting links and the distance B_2 between springs.

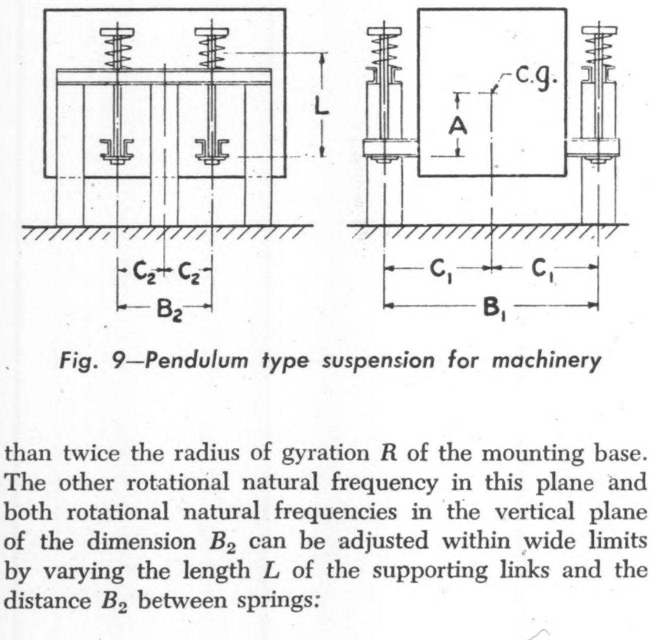


Fig. 9—Pendulum type suspension for machinery

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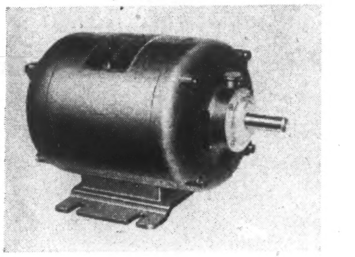
2. "The Use of Rubber in Vibration Isolation"—E. H. Hull, *A.S.M.E. Transactions*, Vol. 59, 1937, Page A-190.
3. *Mechanical Springs*—A. M. Wahl, Penton Publishing Co., Cleveland, 1944, Page 28.
4. "Deflection of Helical Springs Under Transverse Loading"—W. E. Burdick, F. S. Chaplin, and W. L. Sheppard, *A.S.M.E. Transactions*, Vol. 61, 1939, Pages 623-630.
5. Discussion by A. M. Wahl of Reference (4), *A.S.M.E. Transactions*, Vol. 61, 1939, Page 630.
6. *Theory of Elasticity Stability*—S. Timoshenko, McGraw-Hill Book Co. Inc., New York, 1936, Page 75.

new parts and materials

To obtain additional information on these new developments See Page 275

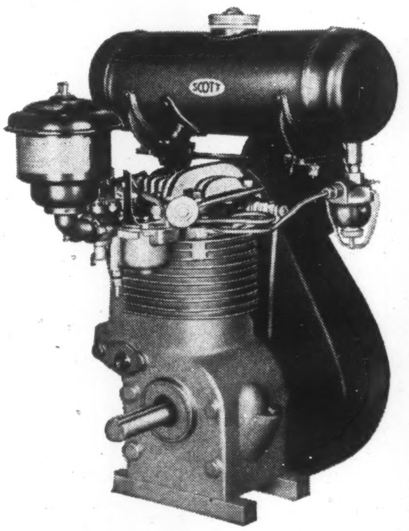
Fractional-Horsepower Motors



LINE OF fractional-horsepower synchronous motors of the capacitor-start, capacitor-run type have the vibration-free performanace of the two-phase motor. The units, which are known as the Cyclohm 29, are available in ratings of 1/100, 1/75 and 1/50-hp when operating at 1800 rpm on 115-volt, 60-cycle power. Featuring extensive use of die castings for parts such as frame, and front and back caps, the motors are well ventilated so as to provide for overload capacities in a given frame size. Sealed and shielded, or self-lubricating bearings are available. If the latter type, they are kept lubricated by a wool wick pulling oil from a large reservoir. Wick is said not to glaze since it is not in contact with shaft. Manufacturer: Cyclohm Motor Corp., 5-17 46th Road, Long Island City 1, N. Y.

For further information circle MD 1 on card Page 275.

Single-Cylinder, Four-Cycle Engine

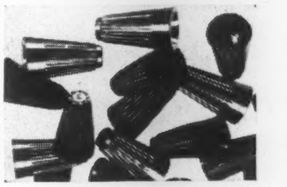


SINGLE-CYLINDER, four-stroke cycle, valve-in-head engine has integral cast crankcase housing and aluminum cylinder block. Designed for simple, low-cost maintenance, the engine features a patented design embodying an easily replaceable head embodying the valve mechanism and combustion chamber. All necessary repair work can be performed without necessity of shop equipment. Engine has replaceable valve guides, cast-iron cylinder liner and a simplified arrangement for valve adjustment. All accessory parts such as the carburetor, filters, etc. are standard. Engine has 2¼-inch diameter, flathead, aluminum piston with a 2¼-inch stroke. Manufacturer: Scott Engine Co., 1 N. Salle St., Chicago 1.

For further information circle MD 2 on card Page 275.

WITH THIS ISSUE a new service is being initiated for your convenience. Because the return postcard system in the "Helpful Literature" section of MACHINE DESIGN has proved of great use to readers, the same service is being extended to the "New Parts and Materials" and "Engineering Dept. Equipment" sections. Each announcement is identified by an MD number so that additional information may be obtained readily by filling in and returning the postcard on Page 275

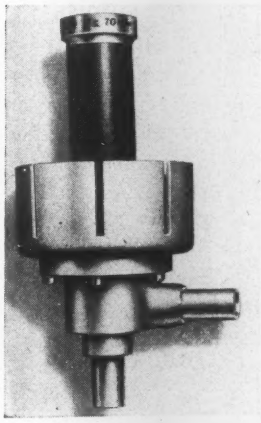
Solderless Wire Connectors



MOLDED PHENOLIC solderless wire connectors are now especially designed for quick and easy joining of standard-gage electrical wires. Known as Scru-It, the connectors are available in several sizes for various combinations of 10 to 18 gage solid or stranded wires. Connectors are not affected by heat, cold or humidity and are used for permanent wire connections, or for roughing-in work without the use of tape, solder or flame. Compact size permits use in switch boxes, fixtures, fuse boxes, etc. Manufacturer: Solar Electric Corp., Warren, Pa.

For further information circle MD 3 on card Page 275.

Water-Cooled Resistor



HIGH-FREQUENCY high-power resistor utilizes a high-velocity stream of water for cooling, the water flowing in a spiral path against resistance film. Through centrifugal force, the flow maintains intimate thermal contact with the entire surface. With interchangeable intake nozzle permitting flow adjustment to suit local water pressure and power dissipation, resistor is designed to permit direct mounting on the end of a coaxial line with both water intake and outlet connections at radio-frequency ground potential. The elements are interchangeable and made to order for range and tolerance. The Type LP resistor is available in types ranging from 35 to 1500 ohms with a resistance tolerance ±15 per cent as a standard and ±10 per cent or ±5 per cent tolerances also are available. Development is recommended for use in such electronic applications as television, FM radio and dielectric heating. Manufacturer: International Resistance Co., 401 Broad St., Philadelphia.

For further information circle MD 4 on card Page 275.

Hydraulic Power Units

SERIES OF high-pressure power units recently designed produces from 1000 to 10,000 psi in the range 0.75 to 34 gpm. The units are quiet in operation, completely enclosed and are furnished with pump, motor, reservoir, filter, oil level gage and adjustable pressure-control valve. Manufacturer is B. F. Perkins & Son, Inc., Holyoke, Mass.

For further information circle MD 5 on card Page 275.

Stainless Steel Electrodes

STAINLESS-STEEL electrodes in a full range of grades and diameters are now available. These electrodes are furnished with a heavy extruded lime-type coating for dc application and, with exception of the straight chrome analyses, ac or dc electrodes are obtainable with the lime-titania type coating. Slag produced with either of these coatings is easily removed. Manufacturer is The Air Reduction Sales Co., 60 East 42nd St., New York 17.

For further information circle MD 6 on card Page 275.

Signalling Timer

SIGNALING TIMER

TIMER gives audible signal at the end of a lapsed period and automatically controls an electrical circuit. When pointer on timer is manually set to the required interval shown on the dial, the circuit closes, and a pilot light indicates that the time interval has started. Moving pointer revolves counterclockwise toward zero, thus at any time in the interval the exact time is indicated on the dial. At end of time interval a buzzer is actuated, pilot light goes out and the circuit opens. The buzzer continues to sound until the toggle switch on the timer is snapped to off position, or the timing interval is reset. Sockets are provided on side of case for either normally-open or normally-closed circuit control. Additional sockets are provided for connection of lights or alarms. Series S timer is enclosed in a metallic-grey case measuring 5 by 5 x 3½-inches. It operates on alternating current, 115 to 230 volts at 25, 50 or 60 cycles. Units are available in dial calibrations ranging from 1 second to 5 minutes with maximum intervals from 1 minute to 3 hours. Manufacturer: Industrial Timer Corp., 110 Edison Place, Newark 5, N. J.

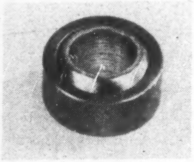
For further information circle MD 7 on card Page 275.

Close Control Thermocouple

THERMOCOUPLE designed for close temperature control utilizes a heavy-wall, seamless, drawn-Inconel protecting tube which fits the element closely for maximum sensitivity and response. The thermocouple, which is supplied with either chromel-alumel or iron-constantan element, is thus assured of long life. Element is supported by ceramic connector body designed to withstand high temperatures indefinitely. Standard lengths from 12 to 48 inches, inclusive, are available in dimensions which are multiples of 6 inches; and lengths from 60 to 144 inches are available in steps of 12 inches. Manufacturer is the Arklay S. Richards Co., Inc., 42 Winchester St., Newton Highlands 61, Mass.

For further information circle MD 8 on card Page 275.

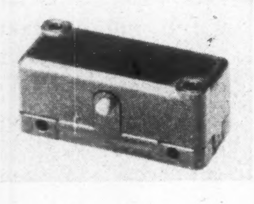
Spherical Bearings



TWO-PIECE spherical bearings for use in installations such as misalignment or rod end bearings of internal combustion engines are hard-chrome plated and completely enclosed in one-piece race of bronze, steel or stainless steel. Bore sizes of the unit range from 3/16 to 3 inches, bearings accommodating ultimate loads from 7,000 to 500,000 lb. Applications of bearings include installation with oscillating rods and tubes of low rpm wherever lubrication by oil or grease is not possible, wherever alignment is expensive to attain, or where rigidity is desired. Manufacturer: Southwest Products Co., 10 S. Catalina Ave., Pasadena 1, Calif.

For further information circle MD 9 on card Page 275.

Limit Switch

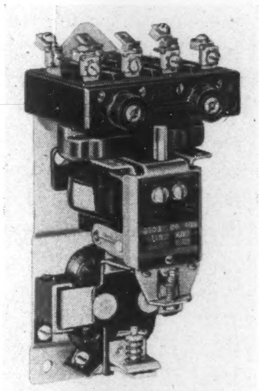


ACTUATED by 1¾-oz pressure, new limit switch functions on a travel differential of only 0.003-inch. The Amptrol switch has been designed for control circuits and pilot operation. In certain applications interruption capacity is adequate to permit safe, direct control of motors as large as 1/3-hp. Entire switch is enclosed in a thermosetting-plastic case with overall dimensions of 1 25/32 by 25/32 by 15/16-inch. Weighing one ounce, the unit is a magnetic snap-action type wherein the actuating plunger loads a leaf spring until the spring load overcomes the pull of an

Alnico permanent magnet, snapping the switch open. Low actuating pressure and short travel differential make the switch ideally suitable for direct actuation by bimetal elements, bellows, or actuators providing slight movement with little force. Switch is available in normally-closed, single-pole, single-throw model. Manufacturer: Friez Instrument Division of Bendix Aviation Corp., Baltimore 4, Md.

For further information circle MD 10 on card Page 275.

Mechanically-Held Contactor



RECENTLY-ANNOUNCED mechanically held contactor features design characteristics similar to magnetic contactors. The new unit may be used to advantage on installations where the slight ac hum of a magnetic contactor is objectionable; or in control circuits where it is necessary to maintain the continuity of operating sequence and no outside interruptions such as voltage failures may occur. Design features straight-line vertical action from magnet armature to contacts, thus minimizing the effects of shock and vibration and the possibility of accidental closure of the contacts. Contactors are available with from two to six poles and for ac operation on voltages up to 600. It is identified as size 00. Manufacturer is the Industrial Controller Division of the Square D Co., 4041 North Richards St., Milwaukee 12.

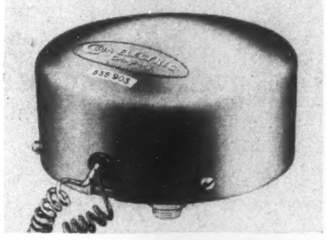
For further information circle MD 11 on card Page 275.

Investment Castings

SMALL INVESTMENT CASTINGS in any castable alloy to tolerances as close as 0.002-inch and with satin-smooth finish have been announced. The castings, which are made under the Jungerson patents, are checked carefully for service defect and when necessary by Zyglo Ultraviolet light process and x-ray examination. Manufacturer is the Cooper Alloy Foundry Co., Hillside, N. J.

For further information circle MD 12 on card Page 275.

Low-Pressure Switch



LOW PRESSURE switch now on the market is suitable for controlling low-pressure blower systems and vacuum filling operations, for hydraulic protective systems and other pressure regulation conditions where small differential pressures must be detected. The switch, Catalog No. 555-903, operates at pressures from 0 to 30 inches of water pressure, vacuum or both; on and off position may be specified anywhere between 0.3 and 10 inches water-pressure differential. Switch draws 6 to 10 amperes at 120 volts ac, weighs 30 oz, and has a ⅛-inch standard female pipe thread for pressure connection. Manufacturer is the Cook Electric Co., 2700 Southport Ave., Chicago, Ill.

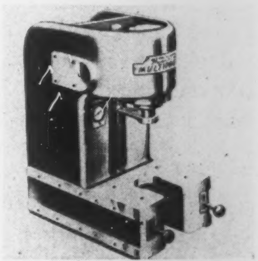
For further information circle MD 13 on card Page 275.

Servo Control for Motor Positioning

REMOTE-POSITIONING servo control will accurately position one or more distant electric motors according to the setting of the control transmitter. Known as Synchro-Link, this servo is designed as a power package. Same standard elements are adaptable without modification to applications such as control of speed transmissions, valves, dampers, machine tools, etc. Unit operates on the principle of a self-balancing electronic bridge. It consists of three basic elements: Master control which may be manual or fully automatic, electronic controller, and load-control potentiometer. Accuracy of the control is better than one per cent for full range of control. Operating on 115-volt 60-cycle power, the unit is capable of handling 15 amperes at 115 volts ac, or 10 amperes at 220 volts ac. Motors up to 1/10-hp can be connected directly, while motors in the range 1/10 to 35 hp use a standard magnetic reversing relay. Manufacturer: Yardeney Laboratories, 105-107 Chambers St., New York 7.

For further information circle MD 14 on card Page 275.

Miniature Presses

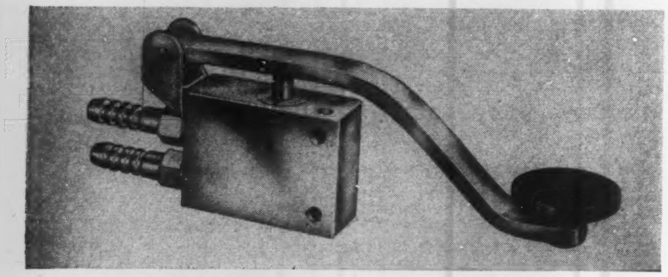


MULTISPEED CONTROL system providing rapid ram speed for approach portion of stroke, and regulative speed for pressing portion, is now provided in an all basic Multipress units. Four-ton unit has a rapid ram speed of 200 inches per minute, a pressing speed regulative between 20 and 200 inches per minute, and an upward ram stroke of 30 inches per minute. Ram pressures may be varied between 800 and 8000 lb. In the six-ton unit rapid ram speed is 180 inches per minute, pressing-speed is regulative between 20 and 180 inches per minute and upward ram speed is 270 inches per minute with pressures regulative between 800 and 12,000 psi. Raising hand levers slightly and momentarily at any point in their downward travel results in a changed ram speed for the remainder of the stroke. Pressing speed is regulated by means of a simple knurled-knob adjustment screw. All units have adjustable stop-collars on their shipper rods for limiting upward and downward ram travel or stroke. Multipresses are adaptable to countless different applications in manufacturing fields. Manufacturer: Denison Engineering Co., 1160 Dublin Rd., Columbus 16.

For further information circle MD 15 on card Page 275.

Fingertip Pneumatic Valve

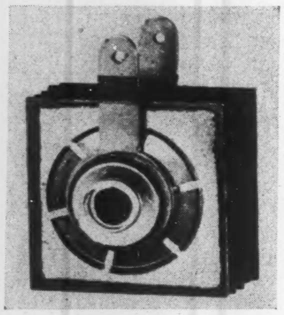
NEW PRECISION-BUILT three-way fingertip valve has capacity to give fast action to cylinders up to 4-inch bore. The valves, of solid-block construction, are provided



with through mounting holes to facilitate location on machine. Travel of button from fully-closed to fully-open position is only ⅛-inch. Manufacturer is the Mead Specialties Co., 4120 North Knox Avenue, Chicago 41.

For further information circle MD 16 on card Page 275.

Selenium Rectifier



MINIATURE five-plate selenium rectifier designated as Type 5M1 is offered by the Seletron Division, Radio Receptor Co., Inc., 251 W. 19th St., New York 11. The new rectifier measures one inch square, features high current capacity and low loss. Cool operation is assured because the rectifier has no heat producing tube filaments. Rectifier is designed for use with a 25-ohm series resistor and a maximum capacitance of 40 μfd. Maximum continuous current is 100 milliamperes at 35 C. DC output voltage and maximum ac input voltage are 130 volts.

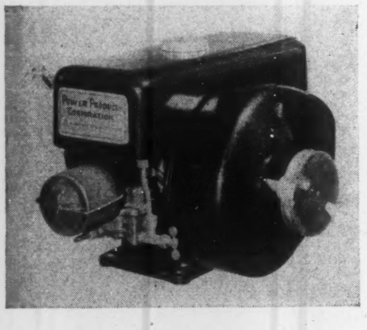
For further information circle MD 17 on card Page 275.

Electric Heating Unit

HEATING UNITS for use in air conditioning ducts are announced by Industrial Chamberheat Laboratories, 2103 Centre St., West Roxbury, Mass. The units are built into turning vanes placed at turning points of ducts. Thus pressure loss is decreased rather than increased. Units are available ranging in size from 3 by 12 in. to 24 by 36 in. and having heat capacities ranging from 15,000 to 1,240,000 Btu per hour.

For further information circle MD 18 on card Page 275.

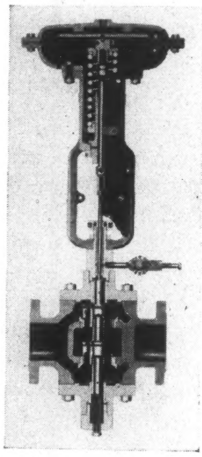
Two-Cycle Gasoline Engine



LIGHT-WEIGHT two-cycle gasoline engine has been introduced by Power Products Corp., Grafton, Wis. This one-horsepower engine weighs approximately 16 lb and occupies 0.8 cubic foot of space. It will run three hours on a tankful of gas and operate at a 45-degree tilt. It is a two-cycle, single-cylinder, air-cooled design with aluminum castings and stampings used throughout, and is recommended for portable and self-propelled equipment such as compressors, pumps, floodlights, bicycles.

For further information circle MD 19 on card Page 275.

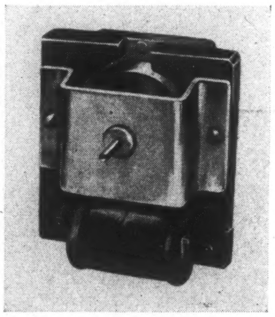
Diaphragm Control Valve



AIR-OPERATED diaphragm motor-control valve recently introduced is equipped with a reinforced molded-neoprene diaphragm designed to respond to the slightest change in signal or air pressure. The new Type 700 valve incorporates a number of new features which includes cradle mounting of the upper spring flange and carefully aged springs. Stem of the valve superstructure is guided in two lubricated bearings wherein lubrication is obtained from a grease cup feeding lubricant to the lower guide as well as to the spring adjustment. Upper stem guide, made of an Oilite bearing, is kept alive under all conditions by this lubrication. Flow characteristics of the valve are of the equal percentage types commonly used with the Belfield valve. Manufacturer is the H. Belfield Co., Broad St. at Hamilton, Philadelphia 23.

For further information circle MD 20 on card Page 275.

Direct-Current Motor



MINIATURE fractional-horsepower dc motor operating on as little as 30 milliwatts power is now being marketed by the Alni Corp., 10 E. 52nd St., New York 22. The Alni minimotor is a self-starting permanent-magnet type motor which will operate in any position and is designed to start in only one direction. Motors are manufactured with different field windings for operation on various specific voltages, and various bearing designs are available to meet needs.

For further information circle MD 21 on card Page 275.

Photoelectric Counter

COMPLETELY PACKAGED, easily installed, general-purpose photoelectric counter now being manufactured consists of a photoelectric control, light source and electric counter. The only equipment which needs to be located at the point of count is the control and light source. One or more electric counters may be placed at any convenient location and wired to the control. Thus, remote control is easily obtained. This counter, known as Type P1, is recommended for counting on loading chutes, conveyors, etc., of small objects. The unit, which is powered by a standard 115-volt 60-cycle circuit, can be

TO THE MANUFACTURER WHO WANTS TO

CUT COSTS

WITHOUT CUTTING QUALITY

Johnson Bronze Sleeve Bearings Give You Every Worthwhile Advantage

- LOW COST
- PRECISION
- QUIET
- LONG LIFE
- CORROSION RESISTANT
- UNIT CONSTRUCTION
- LOAD CARRYING CAPACITY
- HIGH RESISTANCE TO SHOCK
- LOW COEFFICIENT OF FRICTION
- EASY TO INSTALL
- CONFORMABILITY
- NATION WIDE SERVICE

MOST manufacturers find themselves in a critical situation today. Material and labor costs are still advancing. Competition is becoming keener. Some ways must be found to keep finished product prices from going higher. Manufacturers realize that the one who can produce the most efficient unit at the lowest price will command the market.

The low unit cost of Johnson Bronze Sleeve Bearings can make a substantial savings in many cases. You will be pleasantly surprised at the economies possible through the wider use of Sleeve-Type Bearings. Yet this does not mean a compromise with quality and performance. It is simply a matter of selecting the right bearing for each application. Johnson Bronze will be glad to study your needs . . . will make recommendations . . . based on facts . . . free from prejudice. Take advantage of our wide and varied experience in assisting manufacturers of all types of equipment. Write us . . . or phone your nearby Johnson Bronze representative.

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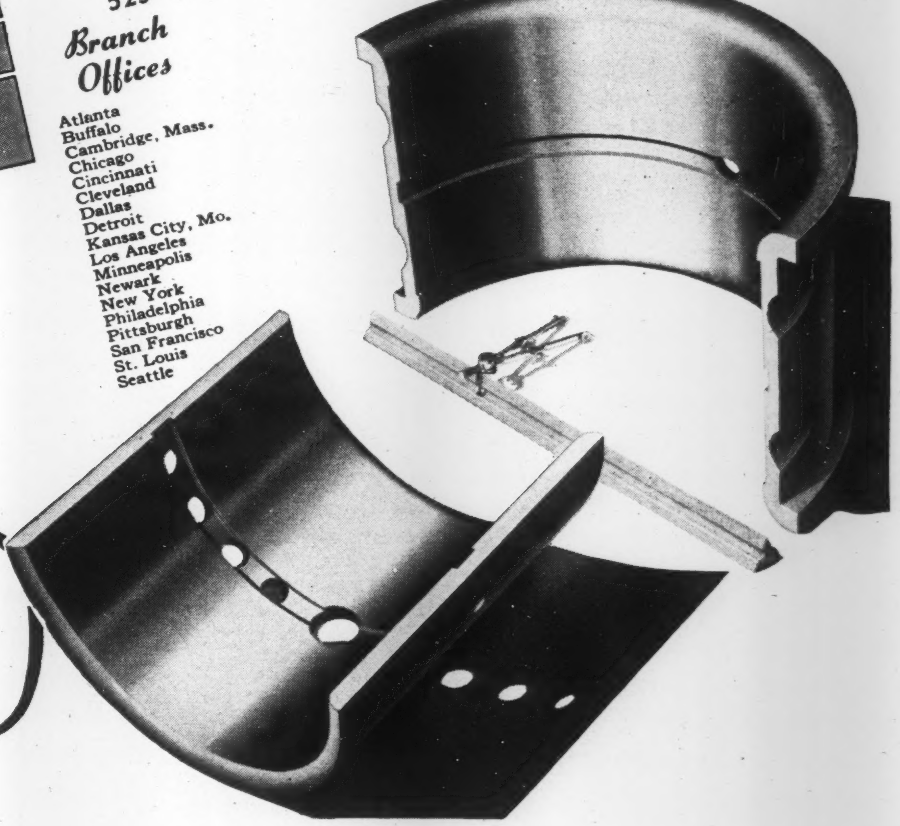


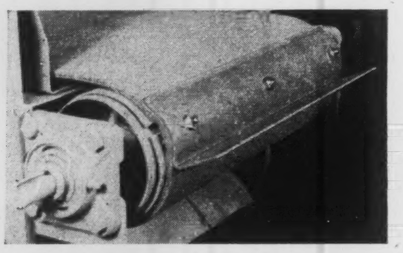
JOHNSON BRONZE
SLEEVE BEARING HEADQUARTERS

used for speed of operation up to 600 counts per minute with maximum number of 100,000 units. Operating range is 6 feet between photoelectric unit and light source. Manufacturer is Photoswitch, Inc., 77 Broadway, Cambridge 42, Mass.

For further information circle MD 22 on card Page 275.

Conveyor Cleat

CURVED TYPE CONVEYOR CLEAT recently introduced cannot be pulled loose regardless of condition of conveyor belt. Cleat is formed from 12-gage steel and is securely fastened to belt with round-head bolts, hug-lock nuts and 13-gage steel reinforcing strip. Fastening of cleat entails drawing a small area of belt within concave side of the bottom leg of cleat, thus freeing the reinforcing strip from contact with conveyor bed and providing a vise-like grip to keep the cleat solidly fastened. This method is said to increase conveyor belt life. Manufacturer is the Rapids-Standard Co., Inc., Grand Rapids, Mich.



For further information circle MD 23 on card Page 275.

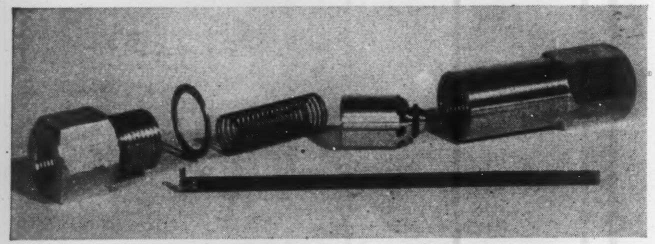
Shielded-Arc Electrodes

COATED NICKEL-CORE ELECTRODE, now obtainable, includes a soft weld-metal deposit which bonds perfectly with all grades of cast iron. The electrode has a nickel content over 99 per cent and has a coating free of fluorides and other ingredients which generate injurious gases. It can be used with alternating current or with either polarity dc. Electrode is manufactured in 3/32, 1/8, 5/32 and 3/16-inch diameters by the Page Steel & Wire Division, American Chain & Cable Co. Inc., Monessen, Pa.

For further information circle MD 24 on card Page 275.

Dual-Seat Check Valve

UNIQUE CHECK VALVE—utilizing a metal-to-metal seat plus a resilient rubber or synthetic rubber ring has been recently developed. The double seal is said to completely eliminate leakage and loss of pressure even with grit in the system. Line pressure forces the resilient ring to the metal seat. Since force increases with pressure, this results in greater sealing force at higher pressures. Available sizes range from ⅛ to 1 inch standard pipe thread for pressures up to 10,000 psi. Valve may be used with any medium not destructive to rubber or synthetic rubber. Manufacturer is the Mansfield & Green Co., 1051 Power Avenue, Cleveland.



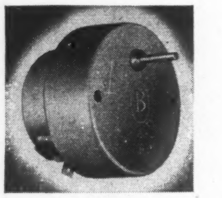
For further information circle MD 25 on card Page 275.

Frequency Control Crystal

MIDGET QUARTZ CRYSTAL oscillator for controlling the frequency of dielectric heating and other instruments measures less than ⅝-inch in diameter and less than 1¼ inches in length. The miniature crystal can be mounted much the same as radio resistors because each end is provided with a pin-type terminal, tinned for quick soldering into the circuit. Frequency of the oscillator is fixed to coincide with value assigned by the FCC for dielectric heating apparatus. Manufacturer is the North American Philips Co. Inc., 100 East 42nd St., New York 17.

For further information circle MD 26 on card Page 275.

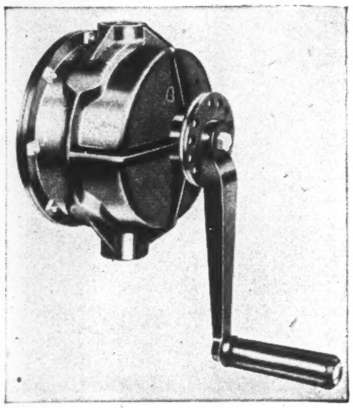
Timer Motor



LINE of timer motors for operation at 1 and 5 rpm on 110, 220 or 24-volt, 60-cycle power will fit within 2-inch circle, has throughholes for mounting and is fitted with easy-to-solder terminals. Other speeds of the Circle B motor will be available at a later date. Manufacturer: A. W. Haydon Co., Waterbury 32, Conn.

For further information circle MD 27 on card Page 275.

Shallow-Well Pump



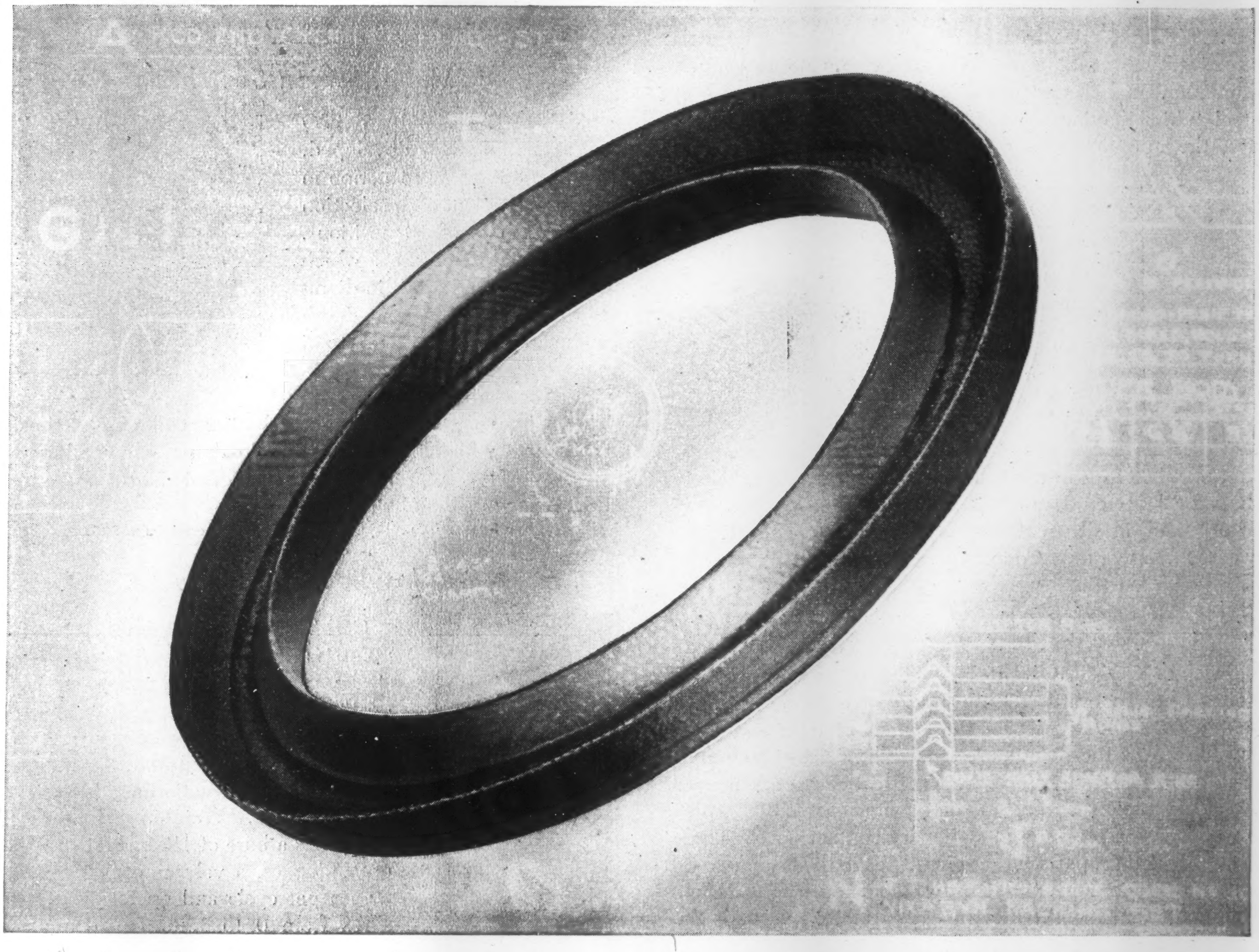
HAND-TYPE shallow-well pump delivering 10 gpm has been placed on the market by the Bogue Electric Co., 42 Iowa Ave., Paterson 3, N. J. Rotor and shaft are supported on ball bearings which are sealed in grease. Bearings do not come in contact with the liquid being pumped, while the plastic vanes employed are positively actuated and will not stick or bind. Maintenance of prime is insured with an ingenious built-in check valve.

For further information circle MD 28 on card Page 275.

Flexible Tubing

SELF-EXTENDING, noncollapsible and retractable flexible tubing is built around a thermoplastic-coated duck fabric, spiral switched around a single, continuous, helical-spring core. There is thus no exposed metal inside or out and the tubing is said to be capable of mak-

V-FOR VIX-SYN! V-FOR VALUE!



Houghton offers 6 distinctive types of fabricated "V" packings

Vix-Syn "V" Packings cover a wide range of operating conditions, including heat up to 700° F., and service against air, gas, water, oil and steam. The synthetic polymers from which these fabricated packings are compounded are reinforced with duck or asbestos fabric for extra strength and durability. Name your problem—we have the packing!

VIX-SYN fabricated "Vs" are one series in the complete line of Houghton packings, including synthetic rubber and the famous VIM Leather, each the leader of its class. Back of them is an engineering service for design aid—yours for the asking. For abbreviated catalog, or full data, write E. F. Houghton & Co., 303 W. Lehigh Avenue, Philadelphia 33, Pa.

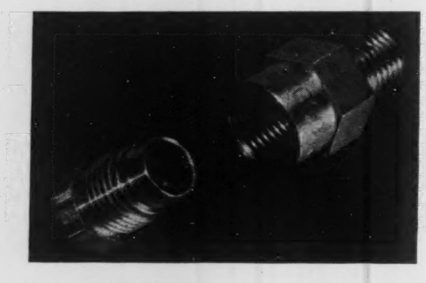
HOUGHTON'S
VIM LEATHER and VIX-SYN PACKINGS

ing sharp turns with minimum crimping and minimum reduction of free area. Known as Spiratube the material is manufactured by the Warner Brothers Co., Spiratube Division, Bridgeport 1, Conn.

For further information circle MD 29 on card Page 275.

Self-Flaring Tube Fitting

NEW TYPE, SELF-FLARING FITTING may be used effectively with tubing of various metals including copper, aluminum, monel, and plastic as well as various types of steel tubing having a wide range of wall thickness. In use, the nut acts as a ram and the body of the fitting as a die, the thrust collar acting as a block and compression member to grip the tube and force it into a precisely shaped 37 degree flare. The tubing is made in sizes from ⅛ to ¾-inch in all usual commercial shapes by the Brockway Co., Naugatuck, Conn.



For further information circle MD 30 on card Page 275.

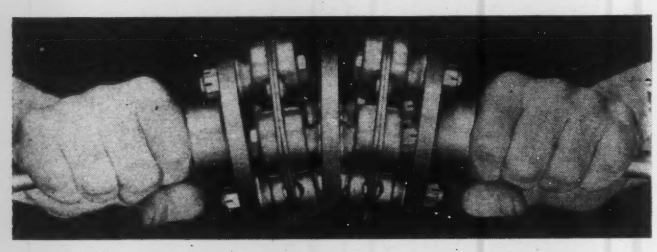
Power Panelboard

STEEL CONTROL PANELBOARD measures 3⅞-inches deep, permitting flush-type panels to be mounted in thin walls. Designed for the control of light and small power circuits the boards are available in 4 to 12 circuits, flush or surface types. Positive electrical contact is assured by steel tension spring in the switch assembly which exerts constant pressure on stationary contact parts. Three current-carrying parts in a circuit have been made 30 per cent heavier and more sturdy than the previous design. Manufacturer: Federal Electric Products Co., 50 Paris St., Newark 5, N. J.

For further information circle MD 31 on card Page 275.

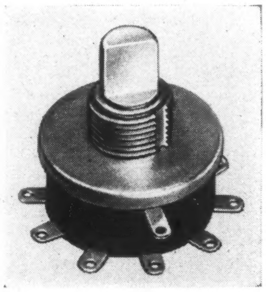
Flexible Coupling

DOUBLE COUPLING consisting of two single Morflex couplings with a center plate adapter has twice the torsional resilience of single couplings. Torsional resilience is obtained through a preloaded Neoprene-biscuit construction. Acting as a universal drive connector, the double coupling accommodates offset and angular misalignment of shafts, permitting constant velocity between driving and driven member. Having no metal-to-metal contact, Morflex requires no lubrication, protects against noise and vibration and has reduced bearing wear while at same time serving as a dielectric. Unit is available in ten sizes with capacities ranging from 13 to 725 lb ft torque. Manufacturer: Morse Chain Co., 7601 Central Ave., Detroit 8.



For further information circle MD 32 on card Page 275.

Multi-Position Switch



SERIES 5000 ROTO SWITCH, newly developed, features 360 degree rotation in either direction and selection from any one of 10 positions. The miniature switch which measures only ¾-inch in diameter and 13/32-inch in depth will carry a current up to 5 amperes and will break a current of one ampere at 110 volts. The switch is available in both shorting and nonshorting types and with shafts for either knob or screw adjustments. Manufacturer is Grayhill Co., 1 North Pulaski Rd., Chicago 24.

For further information circle MD 33 on card Page 275.

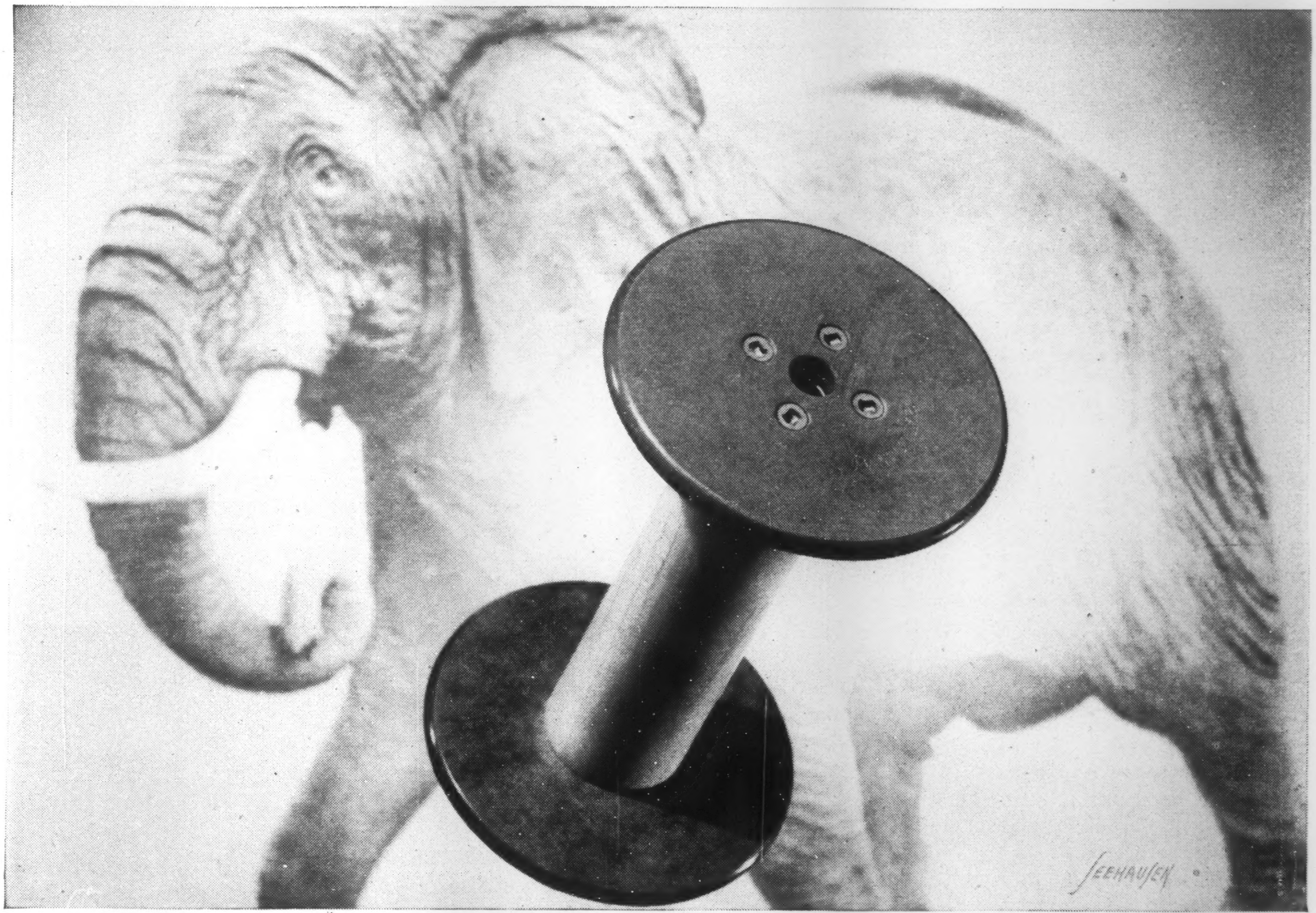
Hydraulic Hand Pump

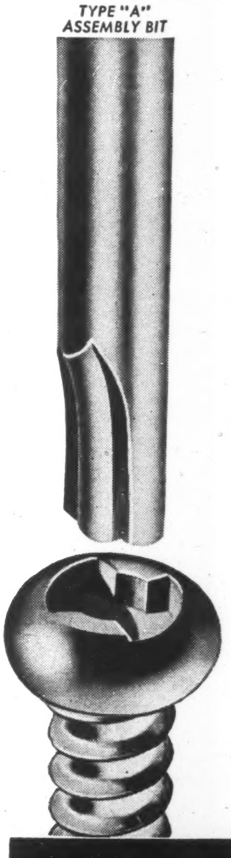
COMMERCIAL hydraulic hand pump is double acting, each hand stroke producing one power stroke of the pump. Developed to meet requirements for a low-cost, efficient, sturdy and simplified unit, the pump is of strong construction and has few moving parts. Weighing 8 lb the pump has a bore of 1¼-inches, stroke of 1¼-inches, a volume of 1.5 cubic inches per cycle and operating pressures from 0 to 1500 psi. Handle load at 500 psi is only 17 lb while at 1500 psi it is 52 lb. With housing measuring 7 3/16 inches long by 3 inches wide 2½ inches high, the unit is of the foot-mounting type with ¼-inch bolt holes provided for easy attachment. Suction and pressure ports are ⅜-inch NPT, both located on same face. The piston rod is chromium plated while the piston rod bearing is bronze. Manufacturer: Electrol, Inc., 85 Grand St., Kingston, N. Y.

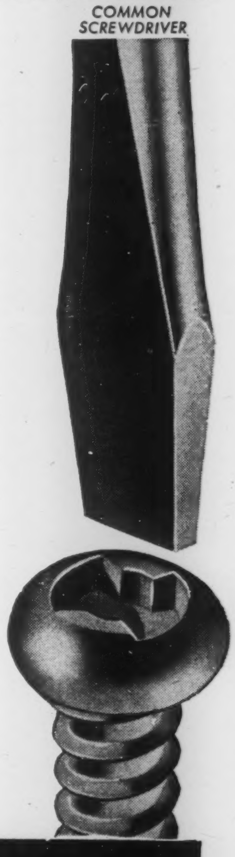
For further information circle MD 34 on card Page 275.

Woven Material

NUMEROUS FIBROUS and nonfibrous materials such as wood, plastics and metals are formed into countless patterns by the new process known as Multi-Weaving. Multi-weave patterns may be composed of materials of the same or different family groups or any combination. Strands and fillers used in process are held securely in







Built for a 2½ Ton Load
and CLUTCH HEAD *"the Only Screw..."*

This Lestershire Bobbin has to endure through a rugged lifetime of precision service . . . frequently taking more than 5000 lbs. stress on the 8″ structure between the heads when winding high tension yarns. The makers of these bobbins, Lestershire Spool & Mfg. Co., Johnson City, N. Y., say:—

> "We had all kinds of trouble with other screws but, with the adoption of CLUTCH HEADS, practically all of our screw trouble has been eliminated . . . it has proved to be THE ONLY SCREW that does not loosen under pressure and vibration.
>
> "The high torque required to drive a 2″ length screw endwise of the grain into hard maple previously *broke the driver, broke the screw head,* or *stripped the driving recess.*
>
> "Using CLUTCH HEAD Screws took us out of all this trouble and sent our PRODUCTION UP A STRAIGHT 50%.
>
> "Damage from driver skidding was a serious and expensive item . . . which your screw has eliminated.
>
> "Our operators are 'for' your all-square, non-tapered driving engagement . . . they vote it easier and safer".

These definite factors for higher production and lower cost, plus smoother and safer operation, merit your investigation of CLUTCH HEAD'S *exclusive features. You may do so at your own desk. Just send for illustrated Brochure, package assortment of screws and sample Type "A" Bit.*

CLUTCH HEAD · SCREWS ·

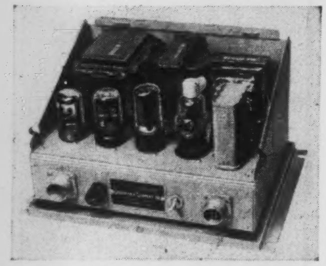
UNITED SCREW AND BOLT CORPORATION

CLEVELAND 2 CHICAGO 8 NEW YORK 7

position under tension at points of intersection and material does not vibrate under acoustical or mechanical force. Weight and size of the design is determined by the gage of the material desired. Single or multiple, wide or narrow strands are used in a variety of colors and different finishes. Typical applications of the new material include air-conditioning grilles, screens, railings, and radio grilles. Manufacturer: General Electric Co., Schenectady, N. Y.

For further information circle MD 35 on card Page 275.

Voltage Regulator



RECENTLY ANNOUNCED ac voltage regulator can be used for the frequency range of 360 to 500 cycles. The unit provides an output voltage range of 110 to 120 volts from an input range of 95 to 125 volts carrying a load ranging from 50 to 500 va. The regulation accuracy is 0.5 per cent with a harmonic distortion of 5 per cent. Unit weighs 12.5 lb and is manufactured by Sorensen Voltage Regulator Co. Inc., Stamford, Conn.

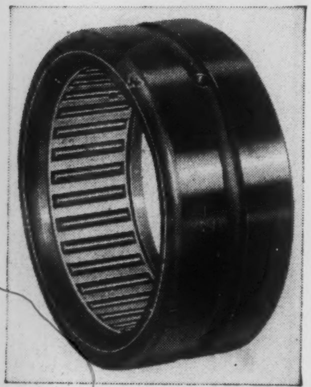
For further information circle MD 36 on card Page 275.

Counters

SMALL, HIGH-SPEED end-drive rotary counter has been added to the line of counters manufactured by the Durant Mfg. Co., 1929 North Buffum St., Milwaukee 1. Designated as the "Y" model, the unit is compact, easily adaptable as an integral part of machinery. The counter has a capacity from 1000 to 100,000,000. Figures are 0.18-inch high by 0.1 inch wide, black on white background or white on black background. The ratio is 10 to 1, or 1 to 1 as specified, with speeds up to 2000 rpm.

For further information circle MD 37 on card Page 275.

Cage Type Needle Bearing



CAGE-TYPE needle bearing is especially suitable for spindles and high-speed applications. It may be used in vertical or overhung applications. Bearing rollers run in a cage fabricated from antifriction, nonferrous material wherein cage pockets are coined to the contour of the rollers. Cage land revolves on outer race preventing pockets from wearing on roller. All parts are Pentrate finished to reduce friction and durability and increase corrosion resistance. Rollers are square-end in design for maximum effective roller length and internal clearance of the cage type bearing can be controlled to meet the exacting specifications. Manufacturer is the Orange Roller Bearing Co. Inc., 557 Main St., Orange, N. J.

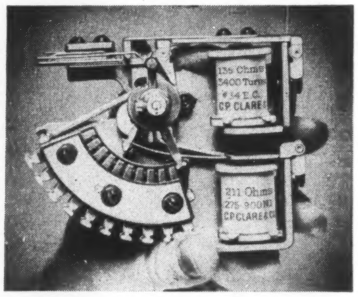
For further information circle MD 38 on card Page 275.

Magnetic Starters

NOW BEING OFFERED by the Federal Electric Products Co., an important addition to its line of motor starters is the new size 3 magnetic starters. They follow the same general design as the earlier sizes but, because of increased size and heavier parts, have greater capacity. Pigtails and flexible jumpers have been eliminated by use of double-break pure-silver contacts. Heavy arc barriers, strategically located, provide high arc-rupturing ability.

For further information circle MD 39 on card Page 275.

Multiple-Contact Switch



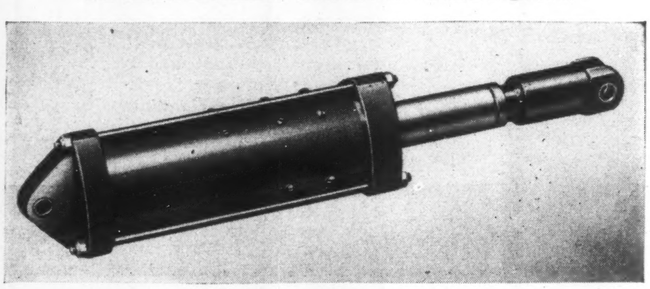
HIGH-SPEED multiple-contact switch for the selection of any of ten channels has been announced by C. P. Clare & Co., 4719 West Sunnyside Avenue, Chicago 30. The stepping switch is supplied with one, two or three-bank levels has an overall height of 4½ inches, width of 1½ inches and length of 3⅝ inches. Maximum operating speed of switch under ideal conditions is 35 steps per second. Release time is 0.03 second. Operating voltages are: Nominal; 6, 12, 24 and 48. Maximum; 8, 16, 32 and 58.

For further information circle MD 40 on card Page 275.

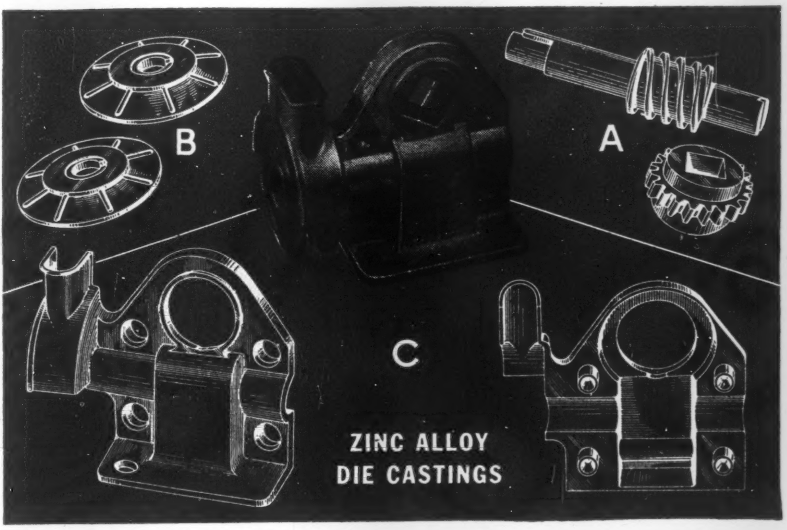
Linear Actuator

ELECTRIC-MOTOR-OPERATED linear actuator now being marketed is a completely self-contained unit of simple design requiring only three connecting wires for installation. The unit, which weighs only 11 lb, 10 oz, is designed for an average operating load of 3500 lb tension or compression and will withstand a static load of 8000 lb tension and 12,750 lb compression. Unit operates at an average load of ¼-inch per second and with a 4-inch stroke. The motor is a 28-volt dc, 31 amperes intermittent duty type, having an average rating of ½-hp. Manufacturer is the Electrical Engineering and Mfg. Corp., 4606 W. Jefferson Blvd., Los Angeles, Calif.

For further information circle MD 41 on card Page 275.



PRACTICAL CONSIDERATIONS IN DIE CASTING DESIGN



FASTENING EXPEDIENTS CUT COSTS

In designing die castings, take full advantage of the possibilities of providing cast fastening elements—rivets, studs, lips, lugs or other projections which can be staked, headed, spun, bent or otherwise deformed to achieve rapid, economical fastening of mating parts. Speed nuts or clips can be used on cast studs, shanks and bosses (see illustration below), or such projections can be threaded or tapped to receive ordinary nuts or screws.

The venetian blind operating device pictured above is an assembly of six *zinc alloy* die castings—with no additional fastening components required. The worm gear shaft (A) has a cast key at one end which is inserted in the slots provided in the center holes of the two flanges (B). These flanges constitute the cord sheave, and they are permanently attached to the shaft by the simple expedient of spinning over the shaft's hollow end. Assembly of the device is completed by inserting the four rivets on one half of the main housing (C) in cored holes in the other half and spinning over the rivet heads. The spinning operations are rapid and economical—thanks to the ductility of *zinc alloy.*

ALLOY SELECTION

The performance of all die castings is based on both good design and proper alloy selection. The *zinc alloys,* covered by specifications of both the American Society for Testing Materials and the Society of Automotive Engineers, can provide the mechanical properties given in the table below. Your die caster understands the necessity for careful control with respect to every element involved in alloy formulation to assure maximum mechanical properties and dimensional stability.

MECHANICAL PROPERTIES OF ZINC ALLOYS FOR DIE CASTING

PROPERTIES*	ZAMAK†-3 A.S.T.M.-XXIII S.A.E.-903	ZAMAK†-5 A.S.T.M.-XXV S.A.E.-925
Charpy Impact Strength Ft.Lb., ¼"x¼" Bar, as cast	43	48
Tensile Strength, Lbs.,/Sq. In.	41,000	47,600
Elongation, % in 2 In., as cast	10	7
Brinell Hardness	82	91

*Properties are as determined on the Zamak alloys. These values, as cast, are well above the minimum A.S.T.M. and S.A.E. requirements.

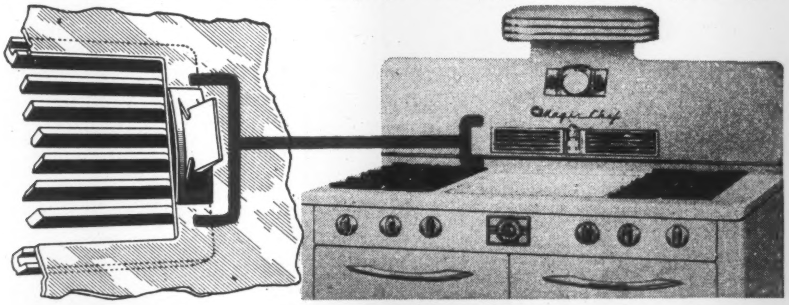
†A trade mark (registered in the U. S. Patent Office) identifying the zinc alloys developed by The New Jersey Zinc Company and used in the die casting industry.

For additional data on die casting design ask us—or your die casting source—for a copy of the booklet "Designing For Die Casting."

Send for your copy

DESIGNING FOR DIE CASTING

A push-on type speed nut with prongs formed to grip the wedge-shaped studs on either end of a die cast grille employed in the splasher panel of a gas range.



ZINC
FOR DIE CASTING ALLOYS

The New Jersey Zinc Company, 160 Front St., New York 7, N. Y.

The Research was done, the Alloys were developed, and most Die Castings are based on

HORSE HEAD SPECIAL (99.99 + % Uniform Quality) ZINC

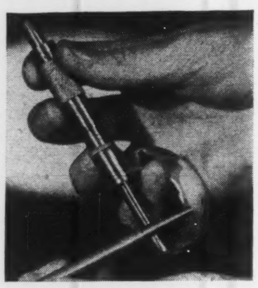
engineering dept equipment

Drafting-Board Cover Paper

PLASTIC-COATED cover paper for drawing board is washable. Soil and grime wash off enabling cover to keep its fresh appearance for a long period of time. Paper has a green tone minimizing glare and reflection, reducing eye strain. It lies flat and is not subject to wrinkling or curling. Regular drafting paper will not mar the nonabsorbent surface. Manufacturer: Charles Bruning Co. Inc., 4754 Montrose Ave., Chicago 41.

For further information circle MD 42 on card Page 275.

Tubular Micrometer



MICROMETER now being marketed has reduced weight and high rigidity through the use of a tubular structure. The new design which reduces weight up to 50 per cent is said to offer greater freedom of movement with touch and feel improving overall precision measuring. Other features of the new micrometer include a wear take-up spindle-bushing assembly compensating for frame wear, and micrometer threads ground from solid bar. Spindle and handle are hardened to rockwell 64 C for wear reduction. Manufacturer is the Tubular Micrometer Co., St. James, Minn.

For further information circle MD 43 on card Page 275.

Yield-Strength Calculator

YIELD-STRENGTH DETERMINATIONS of aluminum and other alloys can be made rapidly by one operator using a new slide-rule type of calculator developed by the Case School of Applied Science. Calculator gives tables and instructions for rapid yield-strength determination of aluminum alloys, brass, copper, carbon and low alloy steels. Printed on stout varnished stock, calculator measures 8 by 10 inches and has vertical movable columns of figures which appear in horizontal slots, enabling operator to correlate quickly diameter of test bar, sectional area, elongation and yield load. Plotting of curves is unnecessary. Manufacturer: Aluminum Research Institute, 111 W. Washington St., Chicago 2.

For further information circle MD 44 on card Page 275.

Intercommunication System

SELECTOR INTERCOMMUNICATION SYSTEM line features five different models of master and remote stations designed to give complete flexibility wherever two-way communication is desired. The number of stations in the line is limited only by the number of selector keys on the master station. Two models have six selector keys, two have twelve keys and the fifth is a remote type through which calls may be initiated and received from the master station. Systems feature cabinets 10⅜ by 7⅛ by 5⅞ inches in streamlined, matte-black plastic with satin-chrome speaker grilles. Selector keys have transparent identification strips for numbers, initials, names or titles of personnel. Furnishing instant, amplified, two-way conversation between two or more points, the unit may be used for quick conferences in which all personnel can participate without anyone leaving his office. In addition, personnel can be paged at several stations simultaneously. Noneavesdrop operation makes it impossible for another station to listen in on conversation not intended. Manufacturer: Radio Corporation of America, RCA Victor Division, Camden, N. J.

For further information circle MD 45 on card Page 275.

Footcandle Selector

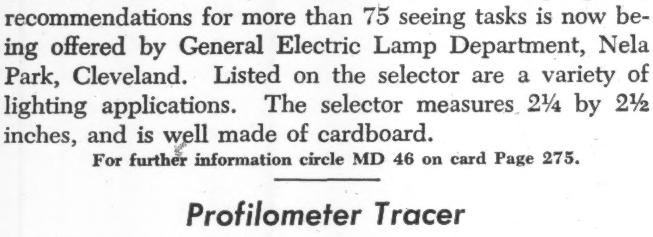
VEST-POCKET footcandle selector indicating lighting recommendations for more than 75 seeing tasks is now being offered by General Electric Lamp Department, Nela Park, Cleveland. Listed on the selector are a variety of lighting applications. The selector measures 2¼ by 2½ inches, and is well made of cardboard.

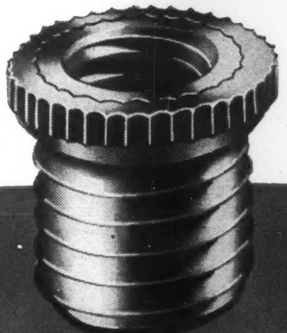
For further information circle MD 46 on card Page 275.

Profilometer Tracer

NEW TYPE tracer now being marketed may be used with a profilometer for taking microinch surface roughness measurements in deep bores such as hydraulic cylinders, camshafts and tubing. Tracer, known as Type LA, will measure to any desired depth in holes as small as ¾-inch diameter. The diamond tracing point is self-adjusting to the work surface. The tracer is mechanically operated by means of a Mototrace and Type BA Linkarm. By using link arms of the proper length for each application, measurements can be taken with the one tracer at various depths to 36 inches or greater. Manufacturer is the Physicists Research Co., 321 South Main St., Ann Arbor, Mich.

For further information circle MD 47 on card Page 275.



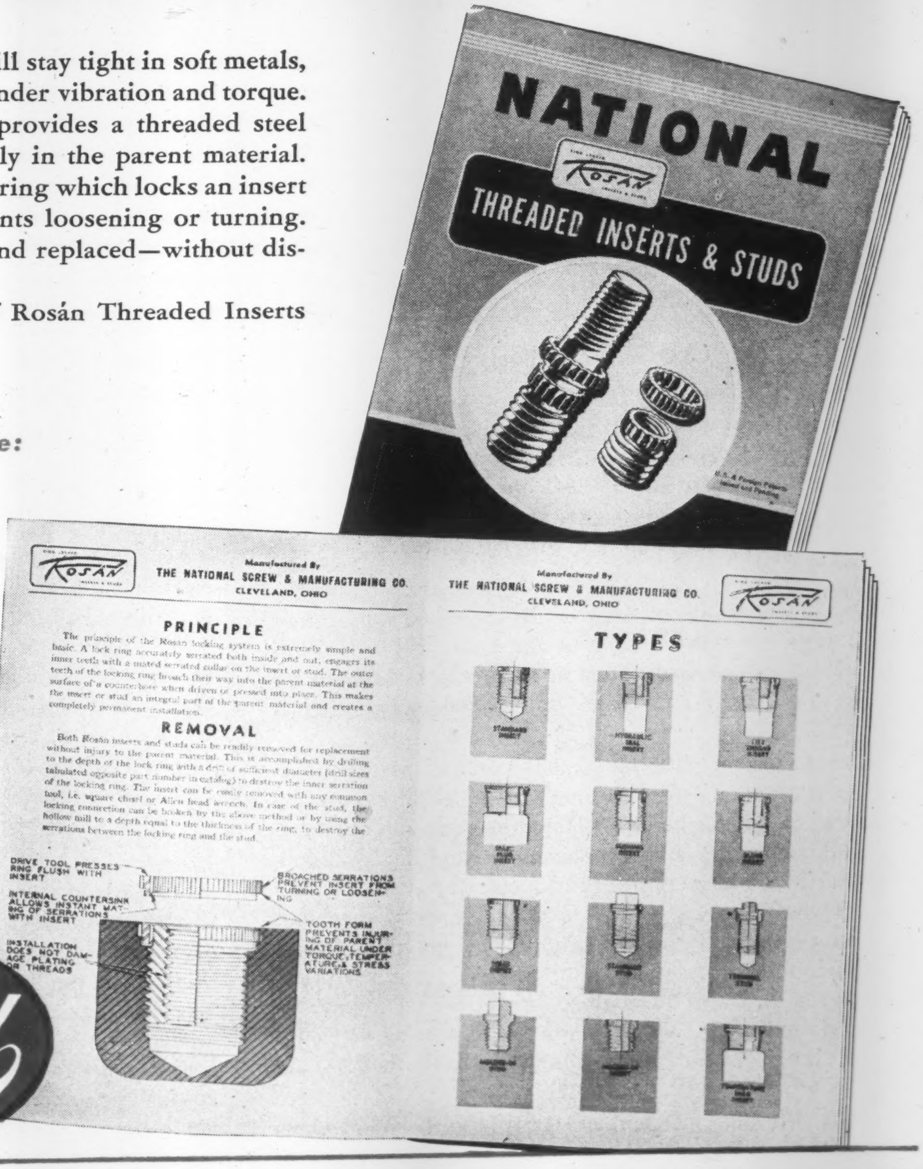


USE THIS THREADED STEEL HOLE FOR TIGHT FASTENING IN SOFT MATERIAL

You can ensure fastenings that will stay tight in soft metals, plastics or bonded metals, even under vibration and torque.

The Rosán Fastening System provides a threaded steel hole (or stud) which holds firmly in the parent material. The design is based on a serrated ring which locks an insert or stud in position and so prevents loosening or turning. It can be removed by drilling—and replaced—without disturbing the parent material.

Send for this useful catalog of Rosán Threaded Inserts and Studs by *National.*



NATIONAL

ROSÁN

THREADED INSERTS & STUDS

Manufactured By
THE NATIONAL SCREW & MANUFACTURING CO.
CLEVELAND, OHIO

PRINCIPLE

REMOVAL

TYPES

DRIVE TOOL PRESSES RING FLUSH WITH INSERT
INTERNAL COUNTERSINK ALLOWS INSTANT MATING OF SERRATIONS WITH INSERT
INSTALLATION DOES NOT DAMAGE PLATING OR THREADS
BROACHED SERRATIONS PREVENT INSERT FROM TURNING OR LOOSENING
TOOTH FORM PREVENTS INJURING OF PARENT MATERIAL UNDER TORQUE, TEMPERATURE & STRESS VARIATIONS

Other "National" Specialties Include:

NAT
TRADE MARK

- **Clutch Head Screws**
- **Davis Blind Fasteners**
- **Drake Lock Nuts**
  - **Dynamic Lock Nuts**
  - **Hi-Shear Rivet Pins and Collars**
- **Huglock Nuts**
- **Laminar Flow Screws**
- **"Lok-Thred" Studs**
- **Marsden Lock Nuts**
- **Phillips Recessed Screws**
- **Place Bolts**
- **Scrivets**
- **Sems**

National
PRODUCTS

THE NATIONAL SCREW & MFG. COMPANY, CLEVELAND 4, OHIO

Assets to a Bookcase

Experimental Stress Analysis, Vol. IV, No. I

By the Society For Experimental Stress Analysis; published by the Addison-Wesley Press, Inc., Cambridge, Mass; 129 pages, 8¾ by 11¼ inches, clothbound; available through MACHINE DESIGN, *$6.00 postpaid.*

This latest group of papers prepared by members of the Society for Experimental Stress Analysis deals largely with strain gage use and evaluation, covering rosette analysis and equations as well as discussing a new type stress gage and presenting numerous nomographs for the determination of strains from rosette data. In addition, this volume presents interesting studies in the evaluation of stresses through use of the brittle lacquer technique and photoelastic analysis, supplementing the data with discussions of several case histories in stress analysis.

Excellent nomographs presented by T. A. Hewson and Norman Grossman for solving strain rosette equations, should be of particular value to those concerned with analysis of this type.

□ □ □

Electrical Machinery

By Liwschitz-Garik and Whipple of the Polytechnic Institute of Brooklyn; published by D. Van Nostrand Co. Inc., New York, in two volumes; Vol. I—DC Machines, 290 pages, Vol. II—AC Machines, 576 pages, both 6¼ by 9¼ inches, clothbound; available through MACHINE DESIGN, *$4.00 and $6.50, respectively, postpaid.*

These two carefully-written books are based upon three books written by the author in the years 1926 to 1934 and printed in German. They have now been brought up to date and largely revised for publication in the English language.

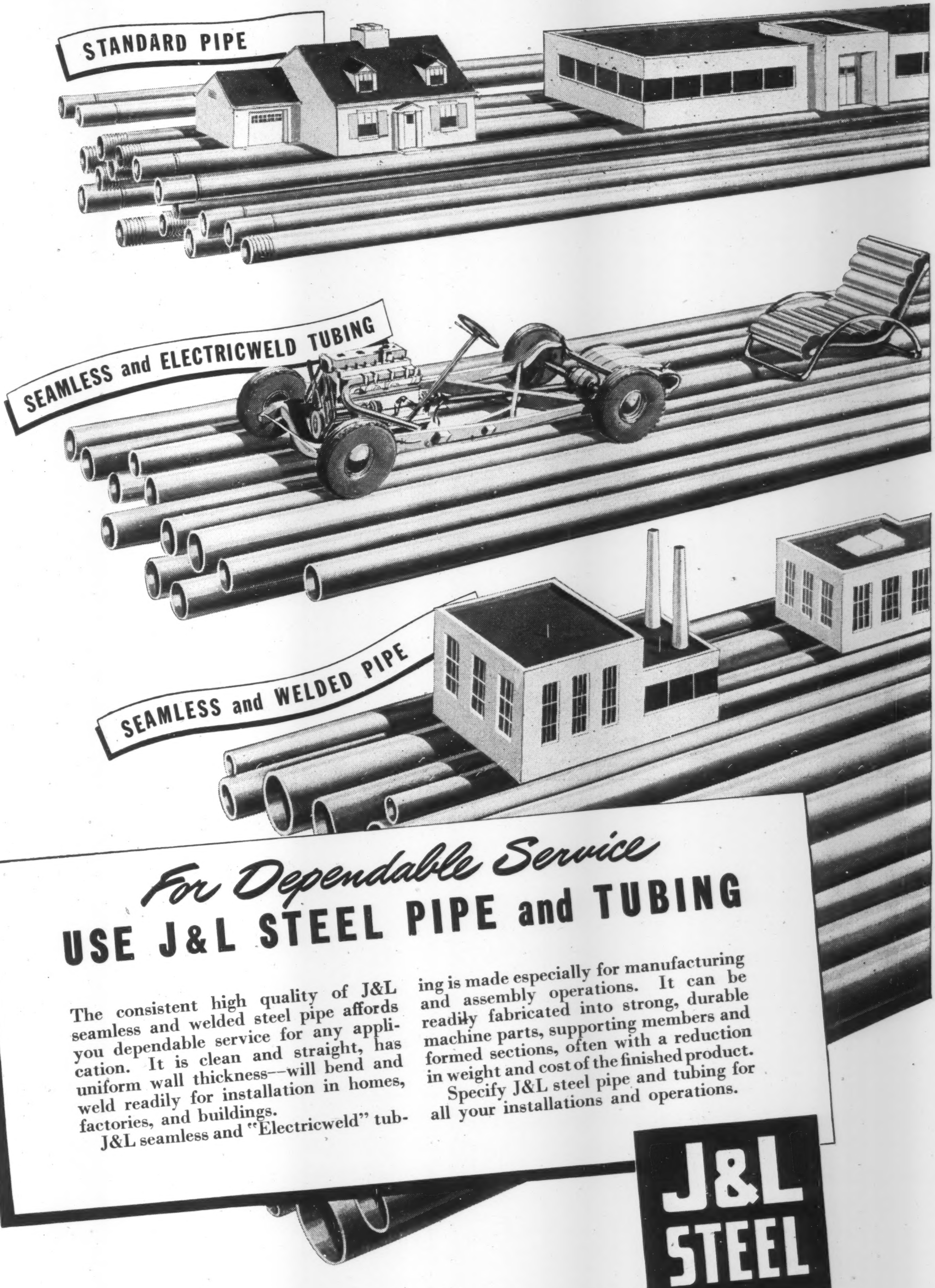
In conformance with the usual practice, dc machines are discussed first, the treatment then leading into the problems of ac machinery. However, the authors have diverged somewhat from the conventional by grouping machines by their operating principles rather than by their use. Thus, induction motors and synchronous machines form one group, repulsion motors and polyphase commutator motors yet another, and so on. In the treatment, attention is called to the features which are common with ac and dc machines. For example, in discussing capacitor motors, their features in common with dc motors are pointed out.

In the first book, DC Machines, the authors introduce the fundamental electrical laws such as Faraday's law of induction, and the circuital law of the magnetic field. Thence, the reader is led through mechanical design, flux calculation, armature windings, heating losses and special machines. In AC Machines, mechanical elements and windings are first discussed, followed by a detailed discussion of motor theory and calculation. Covered are: Induction, synchronous, repulsion, and commutator motors as well as the transformer and the rotary converter. The appendix of the book covers more advanced subjects such as harmonics, transients, the circle diagram, and the capacitor motor, as well as such mechanical aspects as tangential force determination.

Well written booklet on the subject of metal spraying has been recently released in its fourth edition under the name "Metco Metallizing Handbook." The 6 by 8½-inch paperbound book presents in considerable detail data on the properties and methods of application of the Metco type of coating. As is pointed out in the book, proper performance of metallized surfaces is to a great degree dependent upon the preparation of the underlying surface, thus a large portion of the discussion concerns base-metal preparation and various specific problems. Divided into four sections the volume covers: Surface preparation, spraying technique, corrosion-resistance coatings, finishing sprayed metal, and metallizing wires. The 86-page booklet is available at $2.00 from the Metallizing Engineering Co. Inc., 38-14 30th St., Long Island City, N. Y.

Sixteen-page booklet of data on RCA gas and power electron tubes may now be obtained. This 8½ by 11-inch, paperbound presentation gives descriptions, base and envelope connection diagrams, and rating data for power, rectifier and voltage rectifier tubes of industrial and radio types. The booklet is available at 10c from the Radio Corporation of America, Commercial Engineering, Tube Dept., Harrison, N. J.

Scholarly discussion of that oldest form of metal fusion —solid-phase welding—is presented in the booklet of that name by Augustus B. Kinzel. This paper, the official printing of the 1944 Adams lecture before the American Welding Society, covers the theoretical and practical aspects of the art. Illustrating the discussion are a number of photomicrographs, curves and tables. Contained in the appendices are mathematical analyses of the phenomenon of metallic diffusion. The booklet is paper bound, measures 8⅛ by 11¼ inches, and is available at 50 cents from the American Welding Society, 33 W. 39th St., New York 18.



For Dependable Service

USE J&L STEEL PIPE and TUBING

The consistent high quality of J&L seamless and welded steel pipe affords you dependable service for any application. It is clean and straight, has uniform wall thickness—will bend and weld readily for installation in homes, factories, and buildings.

J&L seamless and "Electricweld" tubing is made especially for manufacturing and assembly operations. It can be readily fabricated into strong, durable machine parts, supporting members and formed sections, often with a reduction in weight and cost of the finished product.

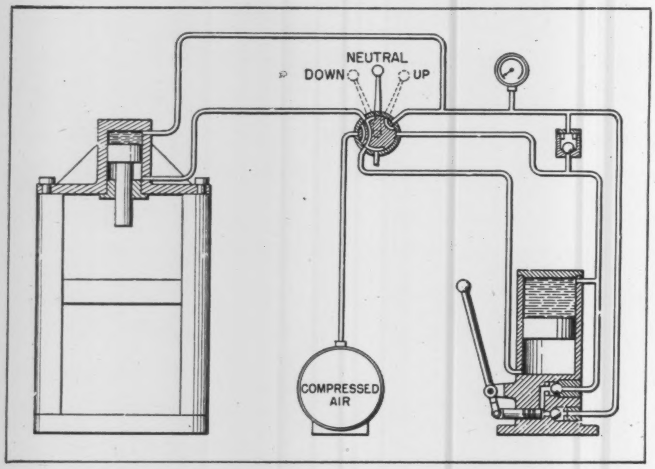
Specify J&L steel pipe and tubing for all your installations and operations.

J&L STEEL

JONES & LAUGHLIN STEEL CORPORATION
PITTSBURGH 30, PA.

Noteworthy Patents

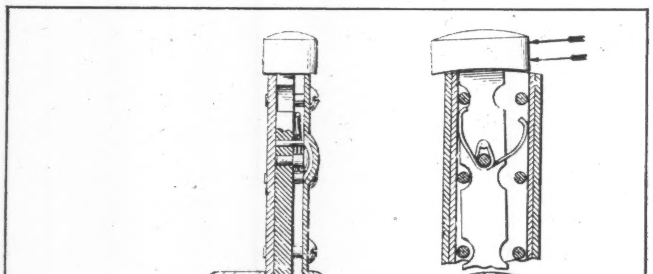
HIGH-PRESSURE manual hydraulic press circuit with most of the advantages of power units is covered in patent 2,413,876 assigned to Bendix Aviation Corp. by James L. Lefler. A combination of compressed air at shop pressure and oil from a hand-operated hydraulic pump is used to achieve high-capacity, low-pressure rapid advance and low-capacity, high-pressure loading or holding. Only a single ram is employed at the press end of the circuit and only hydraulic fluid is introduced into the working chamber of the ram, the fluid being circulated to and from the ram by air pressure. Although separation of air and oil in the pump chamber is advocated in accordance with usual accumulator design, such is not absolutely necessary.



HIGH PRESSURE SEALING, effectively and with flow of fluid from either direction, is achieved with a novel valve seat seal assigned to the Maytag Co. Patented under number 2,414,908 by Thomas R. Smith, the valve seal is completely confined, preventing any possibility of extruding the resilient material. Design is such as to provide self-sealing action under pressure.

INSTANTANEOUS ADJUSTMENT to compensate for relative axial, lateral and tilting movements of rotating parts is provided by a new seal design assigned to International Harvester Co. by Harry A. Land and W. O. Bechman. Covered by patent 2,414,600, the seal is primarily intended for protecting relatively rotating parts such as bearings on crawler-tractor track rollers, shafts, etc. Stationary member of the sealing unit is spring loaded to provide axial sealing force while the moving member provides the self-compensating feature. The actual sealing face of the rotating member is bonded to its attachment flange by means of a ring of synthetic rubber such as neoprene, and misalignments occurring between the two seal units are readily absorbed by the rubber connector which at the same time maintains adequate sealing force between the faces.

AUTOMATIC STEPLESS LOCKING of lever-operated controls is claimed for the device covered in patent 2,414,341. Assigned to Automatic Locking Devices Inc. by Louis Spraragen, the unit utilizes the action of a race and oppositely located wedging surfaces which are locked together by wedging balls or rollers much as a one-way clutch. To overcome the problems associated with fluctuating loads, however, the device employs a separate positive lock and release lever, finger operated. When the release lever is moved in one direction, it unlocks one set of rollers to permit movement of the operating lever in one direction and reverse movement of the release lever moves the other set of rollers out of locking position to release the shaft for turning in the other direction.



BECAUSE IT'S *Tough* TO HANDLE STEEL—

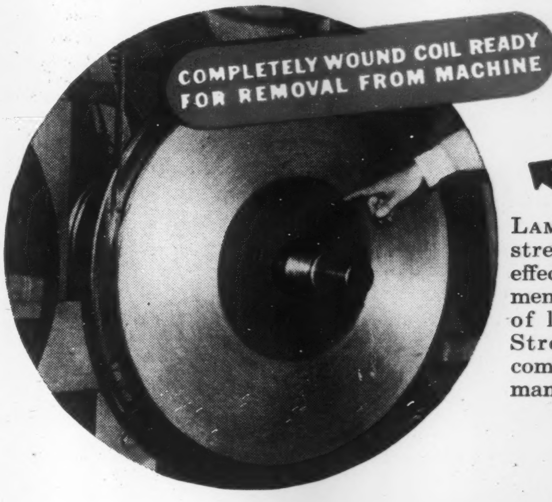
. . . Acme Steel Company of Chicago, Illinois, uses reels made of LAMICOID laminated plastic for winding circular steel coils.

LAMICOID CORE BEFORE APPLICATION TO REELS

Easy to machine, LAMICOID is readily adapted to mass production methods . . . can be worked to metal-precision tolerances . . . will retain its accurate dimensions and shape despite severe usage.

CORE ON REELER READY TO COIL

Light weight of LAMICOID enables reel to be started and stopped quickly—with minimum effort. It's high impact strength resists sudden variations in coil tension.



LAMICOID's exceptional strength and toughness effectively withstand tremendous load of hundreds of loops of steel coil. Strength-weight ratio compares favorably with many metals.

A grade of LAMICOID can be chosen to meet specific product requirements. The wide range of fabric or paper bases—laminated with the proper thermosetting resins—offers designers and manufacturers a selection of materials possessing high electrical and mechanical strength and excellent working qualities. For example, some types resist most oils and solvents as well as many acids and salts. All grades of LAMICOID have low moisture absorption values.

Let our technical representative interpret LAMICOID's many advantages in terms of your particular needs.

COIL IS TIED AND REMOVED FROM LAMICOID CORE

Outstanding wear and abrasion resistance enable LAMICOID core to be used over and over . . . with consequent savings in replacement costs.

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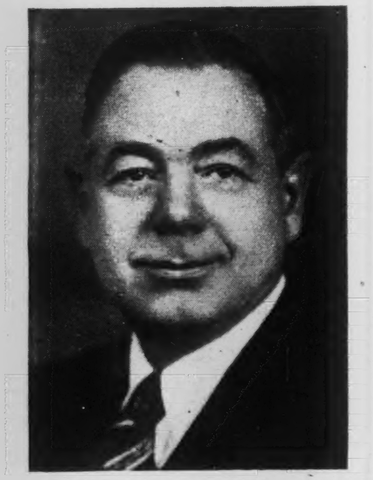
FABRICATORS: Lamicoid Fabricators, Inc., Chicago, Ill. • Bakoring, Inc., Houston, Texas • Insulating Fabricators, Inc., New York City
Insulating Fabricators of New England, Inc., Watertown, Mass.

Photos by Acme Steel Company, Chicago.

MEN...of...machines



Lyndon F. Cole

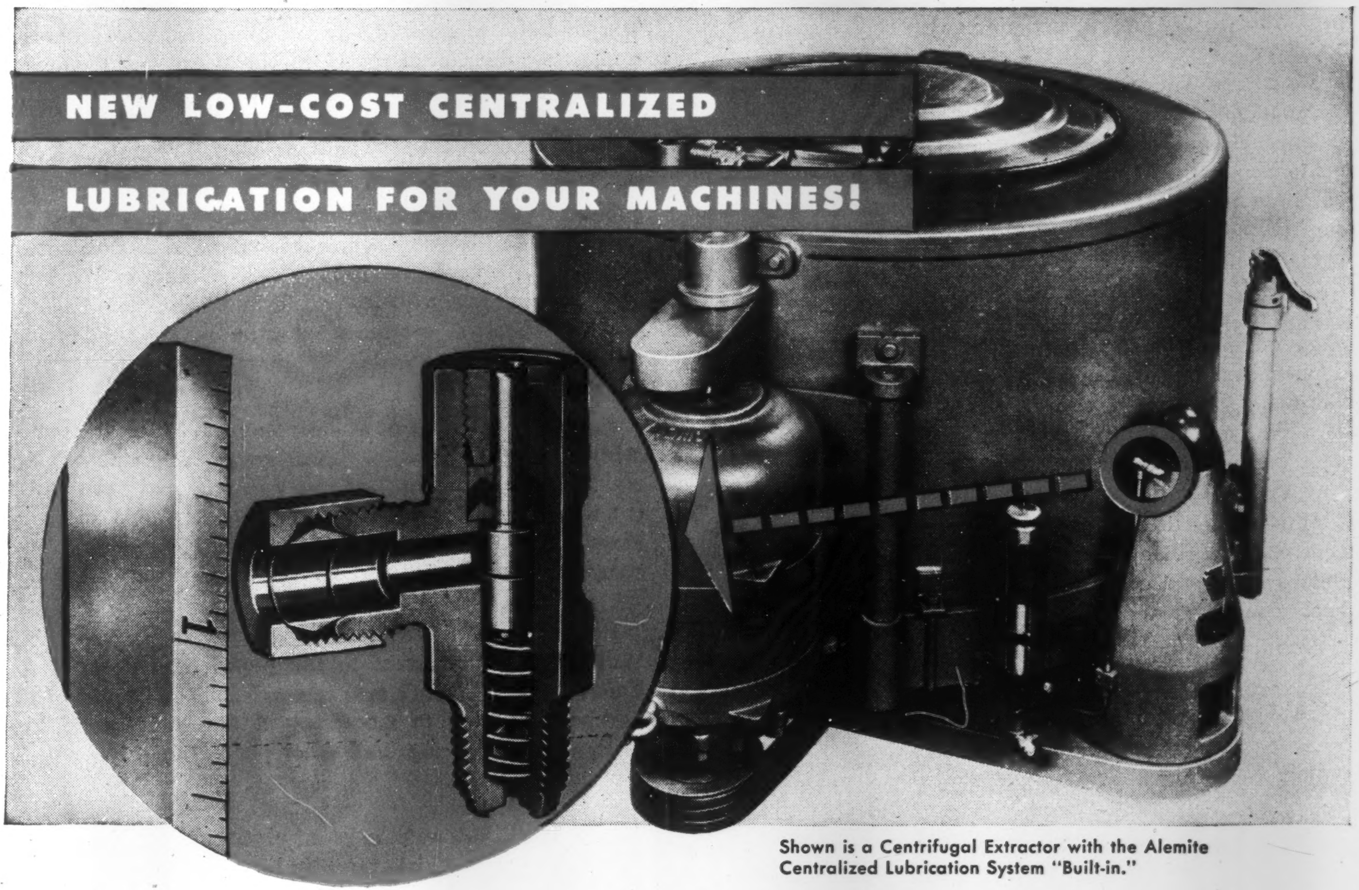
John B. MacNeill

John C McPherson

LYNDON C. COLE in his new position as chief engineer of the machine division of The Osborn Manufacturing Co. will be in charge of engineering and design of the foundry equipment division. In his previous connection as chief engineer of the Cleveland engineering office of the Hydraulic Press Mfg. Co., Mr. Cole was head of engineering and design of hydraulic presses and injection and compression plastic molding machines. Prior to this he was associated with Cleveland Automatic Machine Co. where as chief engineer he supervised the design of single and double-spindle automatic screw machines. In his new capacity as chief engineer of the machine division, Mr. Cole will be able to put to good use his extensive engineering background and experience.

JOHN B. MacNEILL, manager of the switchgear and control division of Westinghouse Electric Corp., has been awarded the 1946 Lamme Medal of the American Institute of Electrical Engineers "for his foresight, leadership and creative contribution in the development of switching equipment". Mr. MacNeill entered the employ of Westinghouse as a draftsman in 1909 and a year later left to attend Massachusetts Institute of Technology. He graduated in 1913 with an electrical engineering degrree, and re-entered the employ of Westinghouse where he has remained continuously. Mr. MacNeill has thirty issued patents and a considerable number are now pending covering modern electrical switching equipment. Mr. MacNeill is in charge of the switchgear division at East Pittsburgh, the porcelain plant at Derry, and the newly-acquired plant for Standard Control, at Beaver, Pa.

JOHN C. McPHERSON, new manager of patent research and development of International Business Machines Corp., has made many outstanding contributions in various phases of the company's activity in mapping future demands and directing engineering development. A graduate of Princeton university, Mr. McPherson joined IBM in February, 1930 as a systems serviceman, then was transferred to the transportation department in the home office. He attended the IBM Sales School in Endicott, N. Y., and, after being graduated, was made a senior sales representative. His promotion to assistant manager of the transportation department again brought him to the home office in New York. With the creation of the future demands department in January, 1940, Mr. McPherson was made manager of that department, and in 1943 was pro-



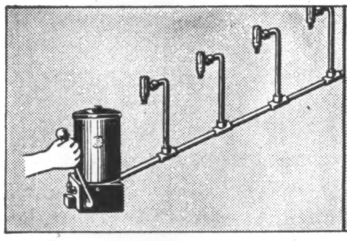
Shown is a Centrifugal Extractor with the Alemite Centralized Lubrication System "Built-in."

IT'S THE ALEMITE "MIDGET"

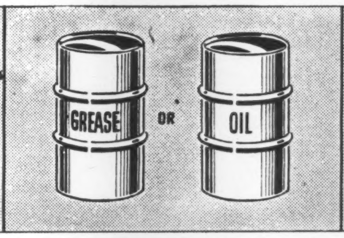
Centralized System . . . Small, Simple, Compact!

● Here's the new Alemite hydraulic measuring valve for Centralized Lubrication that handles either oil or grease. It is only slightly larger than the popular Alemite Fitting. Its small size and simple design make it highly suitable for application to all types of heavy, light and precision machines—especially where space limitations are encountered.

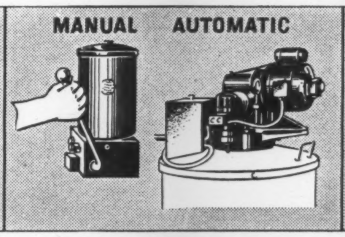
Ask for any technical help. Our Lubrication Specialists will gladly work with you on lubrication problems. They are fully equipped through training and experience to render valuable assistance. Ask for interesting demonstration of Alemite Systems right at your desk with transparent working models. Alemite, 1804 Diversey Parkway, Chicago 14.



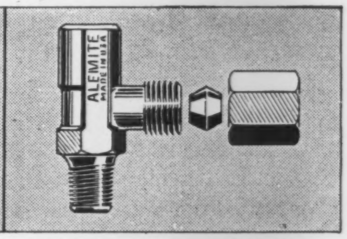
Low Cost, Single Line System. The valves can be mounted on or near bearings, to deliver a measured amount of lubricant from one central point while the machine is producing. No shutdowns, no bearing failures.



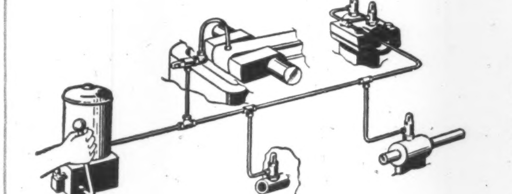
Handles Oil or Grease. There is no danger of over-lubrication or under-lubrication. An indicator signals when the lubrication is completed — eliminating human error. Production goes up . . . costs go down.



Manual or Automatic Operation. A hand pump may be installed in a safe, convenient place on the machine. Or, an Alemite air or electrically operated control will handle a group of machines automatically.



Built-In Compression Fitting is an integral part of the valve and included at no extra cost. No additional fitting is needed to connect tubing to the valve. This is an exclusive Alemite feature.



Serves Any Type of Bearing. Installation accessories are available so that the system can be adapted to rotary, oscillating, stationary — plain or anti-friction bearings.

ALEMITE

Centralized Lubrication
Systems

Another Product of
STEWART
WARNER

moted to IBM director of engineering—the post he has held prior to his present appointment.

◆

Brigadier General Edgar R. Sorensen is the new commandant of the Army Air Forces Institute of Technology, Wright Field, Dayton. Prior to becoming commandant of the AAF Institute of Technology, General Sorensen was serving as senior Air Forces officer on the staff of the Army and Navy Munitions Board in Washington.

◆

Hans Gartmann, at left, has recently been appointed chief engineer of the centrifugal pump and compressor department of the De Laval Steam Turbine Co. Mr. Gartmann, associated with De Laval since 1924, began as a designer of centrifugal pumps and compressors, and later became hydraulic engineer.

◆

Harold V. Rasmussen, center, is the new chief engineer of the turbine department of the De Laval company. Before joining De Laval in 1941, Mr. Rasmussen had been connected with Westinghouse Electric Corp. from 1922-1941, first as a design engineer on industrial, central station and marine turbines, and later as manager of development of stationary and marine turbines.

◆

Harry Engvall, right, the new chief engineer of the helical gear department of De Laval has been associated with the company for twenty-three years.

◆

J. B. Van Der Werff has been made chief engineer, electronics division, Ellinwood Industries, Los Angeles. A graduate of the Detroit, Pasadena and California Institute of Technology schools, he had been associated with Douglas Aircraft and later with Adel Precision Products Co. Under his guidance a new dictating machine is being perfected by Ellinwood.

◆

William S. Knudsen recently has been elected chairman of the board of directors, Hupp Corp.

◆

Edward A. Ledeen, active in the field of production engineering for many years, and most recently chief engineer of Gotham Engineering Co., has been named general manager of Production Methods Inc., New York City.

◆

Henry C. Sheve has been appointed a staff engineer of Stromberg-Carlson with whom he has been connected since 1925. Previous to his release from active service in March, 1946, Mr. Sheve was assistant director of the electronics test division of the U. S. Naval Air Test Center at Patuxent River, Md., with the rank of commander.

◆

Hood Worthington, who has been on assignment at the Hanford Engineer Works of du Pont, has been appointed director of the recently organized engineering research section, Rayon Technical Division, E. I. du Pont de Nemours & Co. Since 1935 Mr. Worthington has been active in equipment design and testing in the field of high-pressure chemical synthesis, contributing to the development of original processing equipment for nylon.

◆

F. K. McCune and B. R. Prentice have been appointed members of the apparatus design engineering staff of General Electric Co. Mr. McCune formerly had been assistant works manager of the company's plant at West Lynn, Mass., and Mr. Prentice had been an engineer in the company's aeronautics and marine engineering division.

◆

Robert F. Golden, formerly with the National Lock Washer Co. as assistant to the president, will head the Eaton Mfg. company's new research and development department devoted to research and development on lock washers, retainer rings and other production fastening devices.

◆

Col. W. F. Rockwell, board chairman and president of Rockwell Mfg. Co., has recently been elected to the board of directors, United Engineering & Foundry Co.

◆

Frank T. Ward, vice president and chief engineer of the Third Avenue Transit Corp., New York, has been elected chairman and Frank O. Hoagland, vice president of Pratt & Whitney division, Niles-Bement-Pond Co., Hartford, Conn., has been elected vice chairman of the mechanical standards committee of the American Standards Association. Mr. Ward represents the American Transit Association, and Mr. Hoagland the National Machine Tool Builders' Association on the committee.

◆

Matthew Lawman Jr., formerly design engineer with Reynolds Metals Co., Richmond, Va., has joined the Allison Division of General Motors Corp., Indianapolis, as test engineer working on experimental engines.

◆

N. E. Hendrickson has resigned as vice president and chief engineer of the Mather Spring Co., Toledo, O., to become engaged in consulting engineering and metallurgical work on the Pacific coast.

◆

George E. Vybiral has been appointed assistant chief engineer of Panelyte Division, St. Regis Paper Co.

◆

William H. Moritz, previously chief engineer with C. D. Beck & Co., Sidney, O., is now connected with the engineering department of Checker Cab Mfg. Co., Kalamazoo, Mich.

◆

Robert H. Davies, formerly manager of technical service for The Parker Appliance Co., will head a new engineering division devoted to product development, product engineering and technical service.

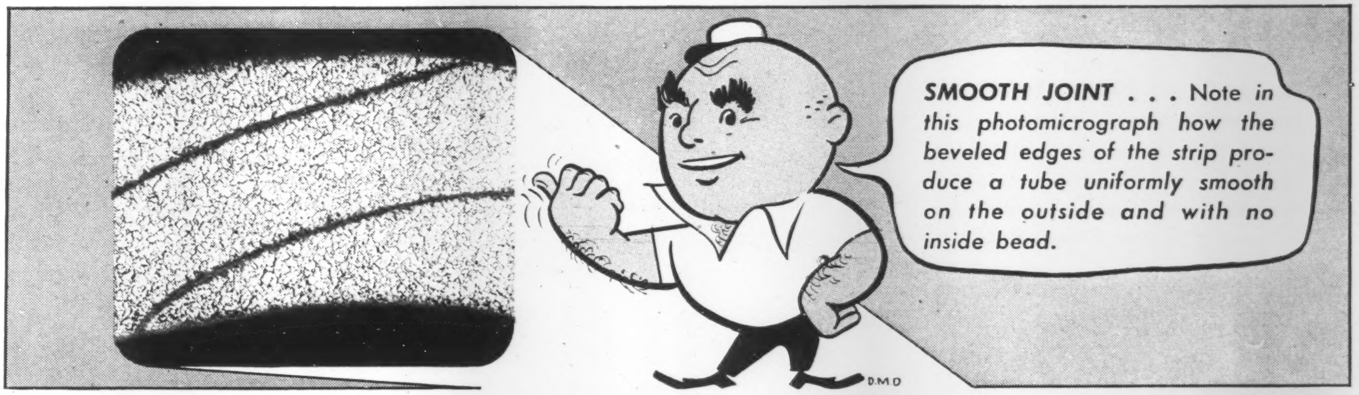
Wichita City Library

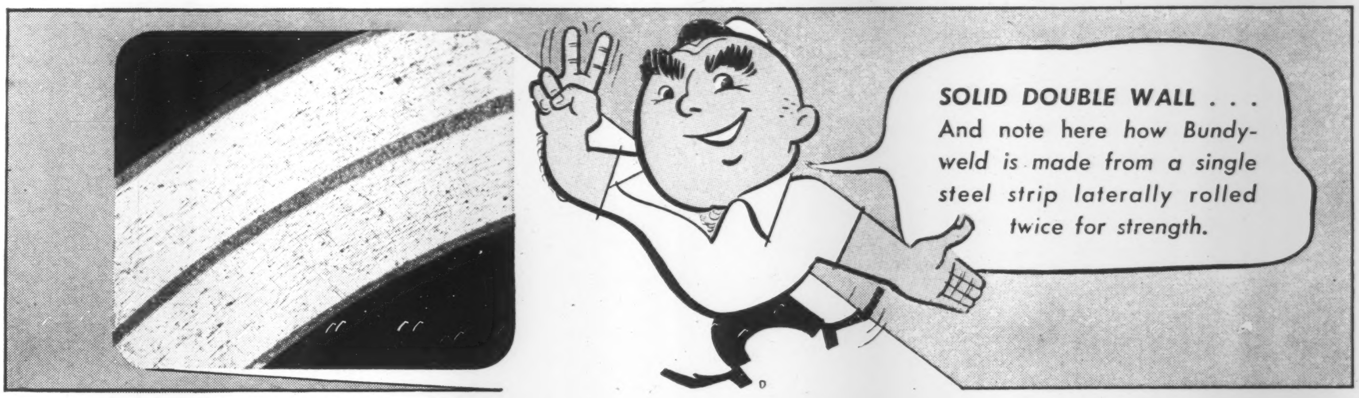
For men who look before they leap

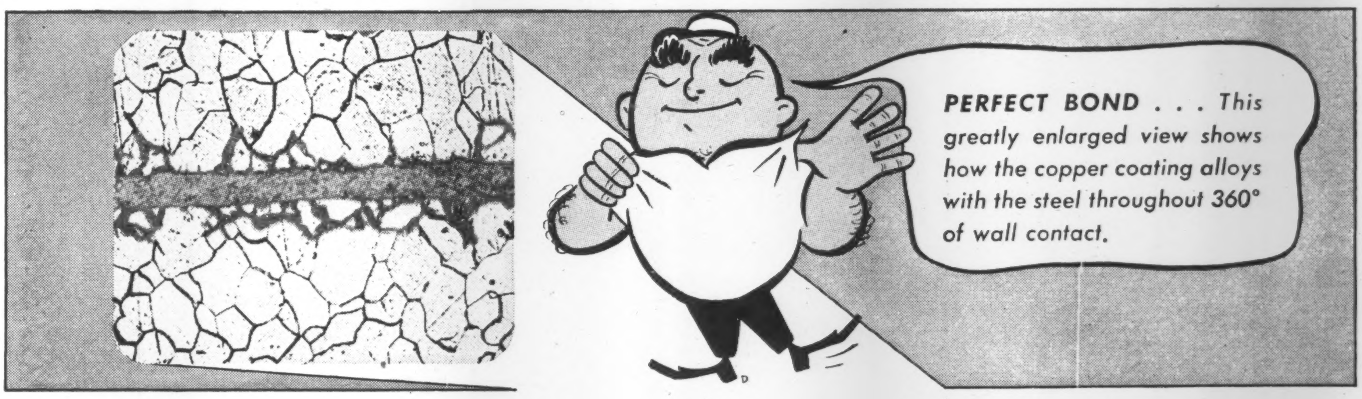
Our favorite people are men who always look before they leap.

Practically all our customers and prospects are that way—they want to *see* what Bundyweld is and why Bundy Tubing is different.

So we show them. Once they get a look at Bundyweld superiority, they almost always leap for an order blank. Here's what they see:


SMOOTH JOINT . . . *Note in this photomicrograph how the beveled edges of the strip produce a tube uniformly smooth on the outside and with no inside bead.*
D.M.D


SOLID DOUBLE WALL . . . *And note here how Bundyweld is made from a single steel strip laterally rolled twice for strength.*


PERFECT BOND . . . *This greatly enlarged view shows how the copper coating alloys with the steel throughout 360° of wall contact.*

This inside story shows why Bundyweld Steel Tubing is specified by hundreds of discerning manufacturers of high-quality products. Bundyweld uses are many—from motor vehicles to refrigerators, from gas ranges to Diesel engines. If your requirement is for outstanding mechanical properties, let us tell you more about Bundyweld. Also available in nickel and Monel. *Write: Bundy Tubing Company, Detroit 14, Michigan.*

BUNDY TUBING

★ ★ ENGINEERED TO YOUR EXPECTATIONS ★ ★

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Standard Tube Sales Corp.
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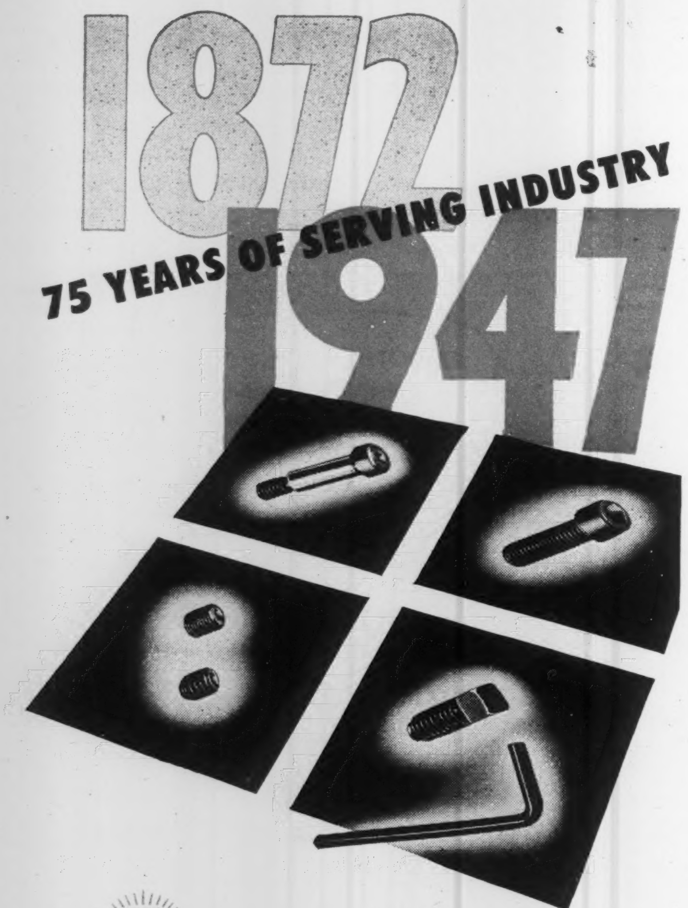
Lapham-Hickey Co.
3333 W. 47th Place
Chicago 32, Illinois

Rutan & Co.
404 Architects Bldg.
Phila. 3, Pa.

Eagle Metals Co.
3628 E. Marginal Way
Seattle 4, Wash.

Alloy Metal Sales Ltd.
861 Bay St.
Toronto 5, Canada



OUR 75th ANNIVERSARY

1947 marks an important milestone in the history of The Chicago Screw Company, identifying it as a veteran leader in its field.

During its 75 years of progress, The Chicago Screw Co. has compiled a vast store of knowledge and skill that makes its products a standard of perfection in the screw fastening industry.

Apace with this growth in craftsmanship has been the constant addition of machines and tools to keep every process in Chicago Screw production the most modern known.

Chicago "Safety Plus" Socket Screws always represent the highest standard of quality. Outstanding in strength, clean and true dimensionally, "Safety Plus" fastenings are ideal for modern production methods.

Chicago "SAFETY PLUS" line includes:

Socket Head Cap Screws • Socket Set Screws • Stripper Bolts • Square Head Dog Point Set Screws • Socket Pipe Plugs • Keys for "Safety Plus" Products.

Complete line includes:

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D-C Relays

(*Continued from Page* 121)

ing resistor are left in the circuit to provide a slow, armature shunt, jogging speed in the neighborhood of one-third base speed. This can be accomplished by interrupting the circuit to the accelerators and the DB switch with the jogging pushbutton or relay.

If jogging at base speed is desired, the FA relay can be kept closed by by-passing the 2A interlock in the circuit of coil FA 2 with a normally-closed contact of relay JR. However, more frequently the motor is allowed to come up to a speed corresponding to the rheostat setting, provided the jog button is held down long enough.

Connects Brake Solenoid to Line

Brake Relay: It is not uncommon to have some kind of a brake on the motor or drive which must be released electrically when the motor is started. On across-the-line alternating-current motors the brake solenoid generally can be connected across the motor terminals. On direct-current, however, the brake cannot be connected across the motor armature because of low-voltage starting. Therefore, a relay usually is employed to connect the brake directly to the line. This relay can be picked up by interlocks on the main contactors, the same as relay FP in *Fig.* 1.

Fast-Speed Relay: On some installations it is desired to raise the speed of a motor temporarily from a hold-down pushbutton. This is done either by inserting the full rheostat or by transferring the field to another preset resistor. In order to insert the rheostat by means of a relay, the lever of the rheostat must be brought out to a third terminal. If the speed is changed by 2:1 or more in this manner, it will probably be necessary to provide field accelerating and decelerating relays.

A special circuit of this type is shown in *Fig.* 9 where a graduated fast speed is obtained, depending upon the setting of the rheostat. That is, the motor will speed up to higher speeds, by pushbutton operation, as the rheostat setting is made higher.

Graduated Speed Increase Is Desirable

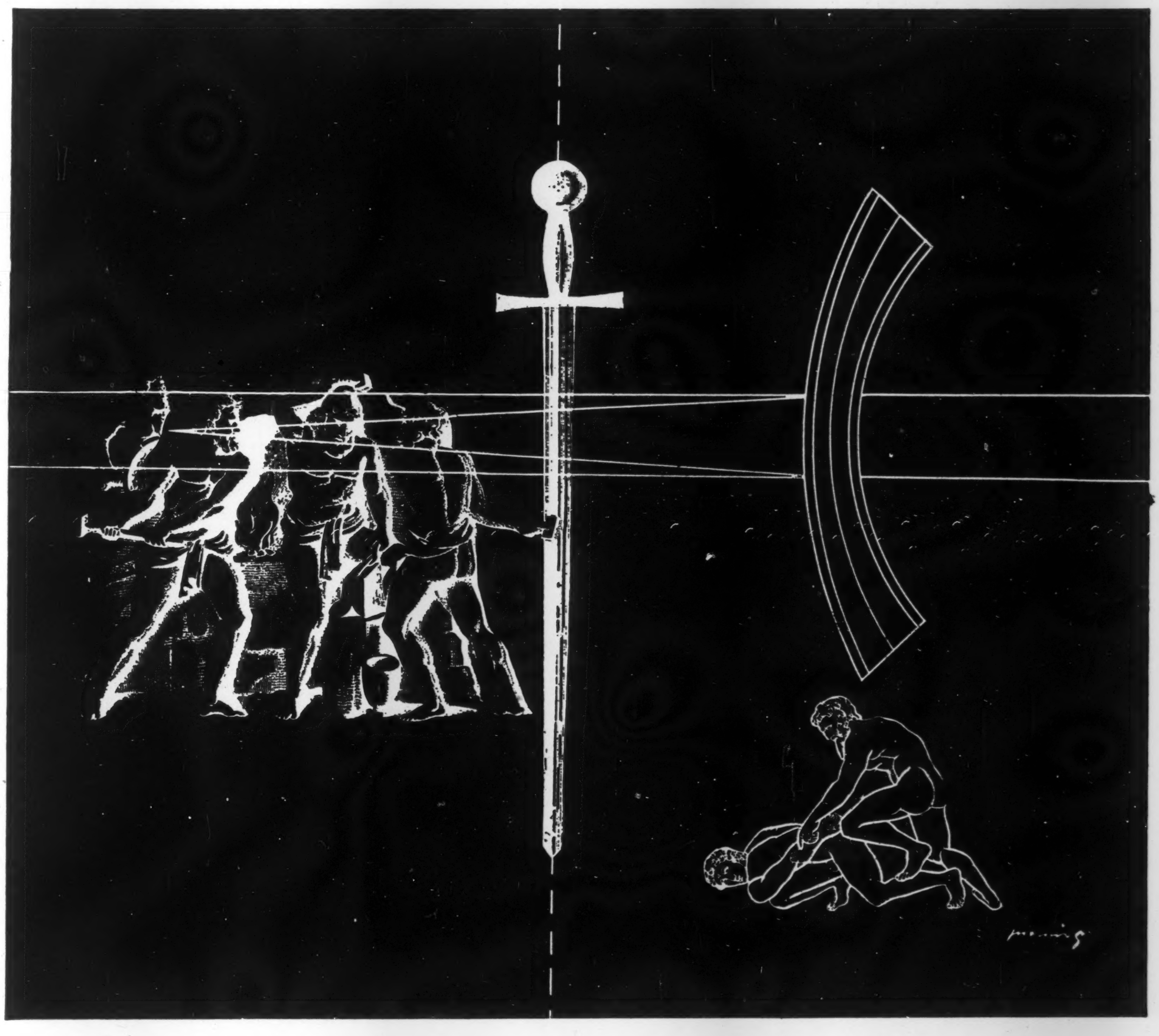
It can be seen that the "fast" pushbutton will insert a resistance which is equal to the parallel combination of that part of the rheostat not already in the circuit and another resistor XY. The value of this resistor can be chosen to give the desired speed increase when the rheostat is set for base speed. Then, as the rheostat setting increases, the "fast" speed will approach the maximum motor speed. This graduated speed increase is less severe on the motor and might also be desirable from the standpoint of machine operation.

Magnetic Blow-outs: In conclusion, a few words may be added which apply to all direct-current relays. Direct current, unlike alternating current, tends to maintain an arc, particularly if the load is highly inductive. For this reason, relay contacts which handle motor field circuits, solenoids, or anything but light control circuits, should

ONE CAME BACK

One of the legends surrounding the making of Damascus sword blades is that the smiths developed a delayed quench consisting of thrusting the heated blade into the body of a slave. This gave the required properties, but it was prodigal of manpower, and inconvenient besides. The smith usually had to leave town to do his heat treating in quiet.

Today, metallurgists can obtain properties they need in steel by simpler, less improvident means. A little molybdenum is one way of doing this. It is a proved means of obtaining the hardenability that assures good performance in service. Practical working data on molybdenum steels are available from Climax upon request.



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Here in this 28-page engineering catalog you will find everything you need to know about spring specifications: 28 fact-filled pages containing all the data necessary to specify springs for any purpose—formulas, graphs, charts, tables and illustrations for all types of springs from light wire to heavy elliptic. Write today for your copy of Catalog 305.

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be equipped with magnetic blow-outs. The blowout coil can be a series coil if the load current is known and if it does not vary.

If the load current is not known or if it varies, as in the case of many field circuits, a more effective blowout can be obtained with a shunt coil. A further advantage of a shunt blowout is that it maintains its strength as the contact current decreases while the arc is being extinguished. The shunt blowout coil is frequently designed to be connected in series with the field discharge resistor.

In either case, a coil should be selected to give the maximum possible ampere-turns in the blowout, the limitation, of course, being coil heating. Effective blowouts will improve operation and greatly extend life of relay contacts.

Locking Fasteners

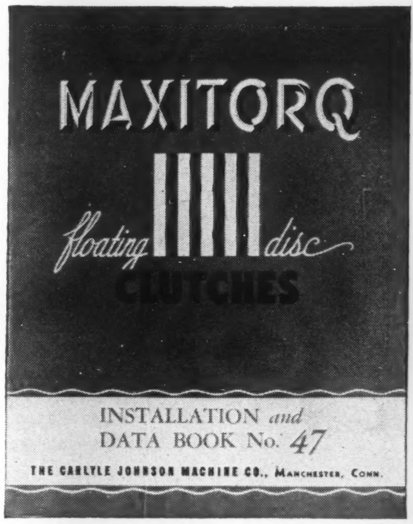
(*Concluded from Page* 132)

upsets the Rivnut shank, securely tightening it in place. This particular fastener has the advantage of also serving as a nut plate since the internal threads are not injured in the locking operation.

QUICK-RELEASE FASTENERS: Originally developed for the aircraft industry, this type of lock, *Fig.* 6, is finding wide use in the machine field as a means of securing panels, plates, etc. While the method of installation varies somewhat, they each function, when in use, as a quarter-turn release device. Most of them, therefore, utilize an over-position cam to achieve this effect. Their speed of locking is consequently quite high.

FASTENER PROPERTIES: The fastener property table will serve as a guide to selection of locking fasteners if terms used are properly understood. A fastener is described as reusable if it can be repeatedly utilized for the application intended. Rivets are therefore usable only once. Quick-release fasteners, however, may or may not be destroyed by complete removal from an installation, but inasmuch as they are designed for repeated disconnection they have been classified as reusable in all instances. Spring effect has been applied in the narrow sense that if the fastener can actually be used to replace a spring, it is considered as having spring effect. Assembly speed has been rated in the light of high-speed power drivers. Since most production work is done with this tool, all threaded fasteners are therefore rated as moderate in assembly. Types of fasteners which may be applied by a thrust action, such as the type of Speed Nut for use with studs, have been rated as fast. Stress properties will of course vary with the size fastener used. They have therefore been rated in comparison with a standard bolt of comparable size. If of equal strength they have been considered as having high properties. If the fastener is not designed for this class of service it has been rated as a low-property type.

Because of the wideness of the subject, reference has been made in this article only to basic and representative types of each fastener design. There are in many instances a great number of variations of design to suit special problems. Speed Nuts, for example, are available with special extensions for holding and gripping auxiliary members or parts. Modifications of this nature are commonly made by fastener manufacturers.



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floating *disc*

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INSTALLATION *and* DATA BOOK No. 47

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THE REASON WHY

This new Catalog tells the complete story of Maxitorq Clutches ... with detailed engineering drawings and tables. Clearly shows why Maxitorq deserves your attention.

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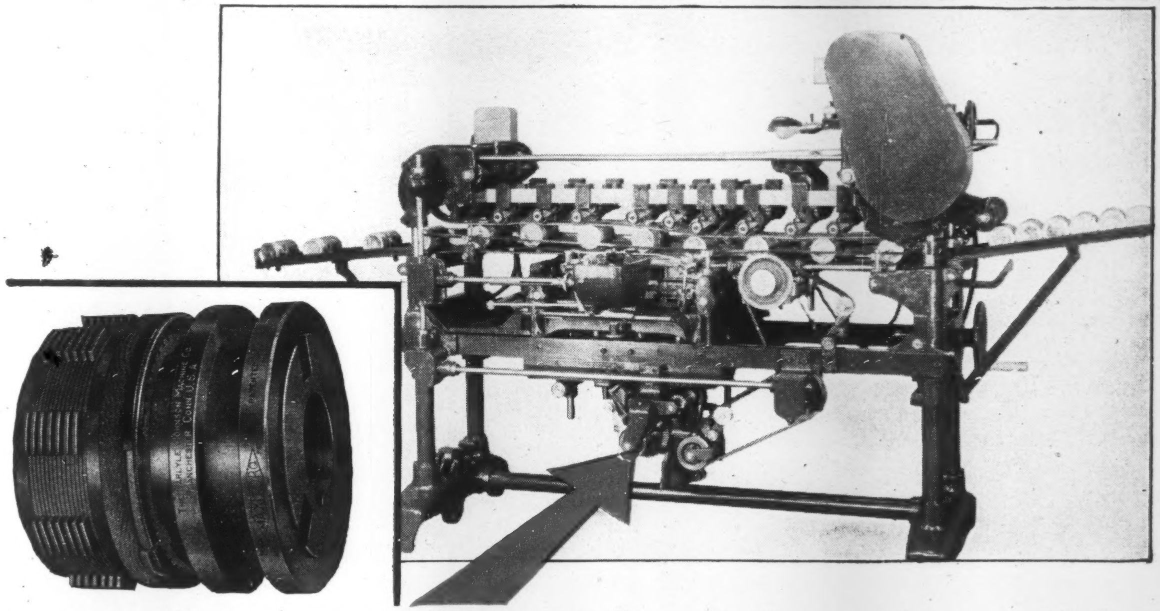
ON HIGH SPEED CAN LABELLING MACHINE



The Standard-Knapp Corporation builds nationally known machinery for high speed labelling of varisized cans. It is vitally necessary to maintain uninterrupted production. Machine down-time is costly ... and faulty power transmission could cause considerable damage to cans, labels and the machine itself.

Therefore, they have selected Maxitorq Floating Disc Clutches ... in both Standard and Automatic Overload Types ... to obtain dependable power transmission with positive clutch action.

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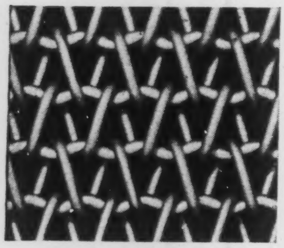

Close-up showing alternate spiral construction and crimped wire connection of Cambridge Balanced Belting.

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BUSINESS AND SALES BRIEFS

APPOINTMENT of the following new district sales managers has been announced by Federal Electric Products Co., Newark, N. J.: William M. Stark, manager of the Southwestern district, with headquarters in St. Louis; George L. Stout, manager of the East Central district, with offices in Cincinnati; and Clarence G. Landeck, manager of the Middle Western district, with headquarters in Chicago.

◆

Previously manager of the Los Angeles district office of Allis-Chalmers Mfg. Co., Arthur D. Brown has succeeded R. N. Landreth as manager of the Washington, D. C., office. Mr. Landreth now will devote full time to his special duties as assistant to W. C. Johnson, vice president of the general machinery division.

◆

Tube Turns Inc., Louisville, Ky., has moved its Chicago offices to suite 904, Fairbanks-Morse Bldg., 600 South Michigan Ave. This will serve as headquarters for George C. Anderson, district manager of the welding fittings division, Donald A. MacNeil, district manager of the forging division, and their staffs.

◆

H. M. Hammond and P. S. Dickey have been elected vice presidents of Bailey Meter Co., Cleveland 10. Formerly Mr. Hammond was general sales manager, and Mr. Dickey, chief engineer.

◆

According to a recent announcement, Albert E. Zeisel has been named vice president in charge of sales of Eutectic Welding Alloys Corp. He has been associated with the corporation since 1944, and most recently served as assistant to the president in charge of sales, with headquarters in the New York office.

◆

With offices at 114 West Broadway, Salt Lake City, Utah, the Frobes Co. has been appointed to serve as sales agent for the Titan Metal Mfg. Co.'s line of brass and bronze products, including forgings, rods, die castings and welding rods. In addition to the entire state of Utah, the Frobes Co. will handle sales in Idaho, Nevada, Wyoming and South Dakota. D. C. Frobes is in charge.

◆

Election of P. E. Lueders as president has been announced by The Phosphor Bronze Smelting Co., Philadelphia 46. A. J. Seiler has been named executive vice president.

◆

Six new sales engineers have been appointed by the Tocco division of The Ohio Crankshaft Co., Cleveland. They are: Marvin E. Hackstedde, previously with the home office sales department, to cover western Pennsylvania with headquarters in Pittsburgh; B. F. Nemerguth, formerly Tocco service manager, to cover eastern Pennsylvania, southern New Jersey, Maryland, Virginia, North and South Carolina, with headquarters in Philadelphia; R. W. Miller, previously a service engineer and member of the home office sales department, to cover southern Ohio, West Virginia, Kentucky and Tennes-

For a quality product that sells...

USE FASCO QUALITY...
FRACTIONAL H.P. MOTORS

(1/500 to 1/15 H.P.)

Product sales trouble may be averted ... by applying FASCO *experienced* F.H.P. motor engineering and production know-how ... to eliminate motor trouble *before* it starts. A skilled, *experienced* FASCO factory engineer will meet with you in your own plant ... engineer the electrical and physical characteristics of the motor you need ... and adapt a *standard* motor to your product's *special* requirements. For superior product sales advantages, consult with us NOW, if your plans call for production-run quantities of small motors (1/500 to 1/15 H.P.) or blowers.

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F. A. SMITH MANUFACTURING CO., INC.
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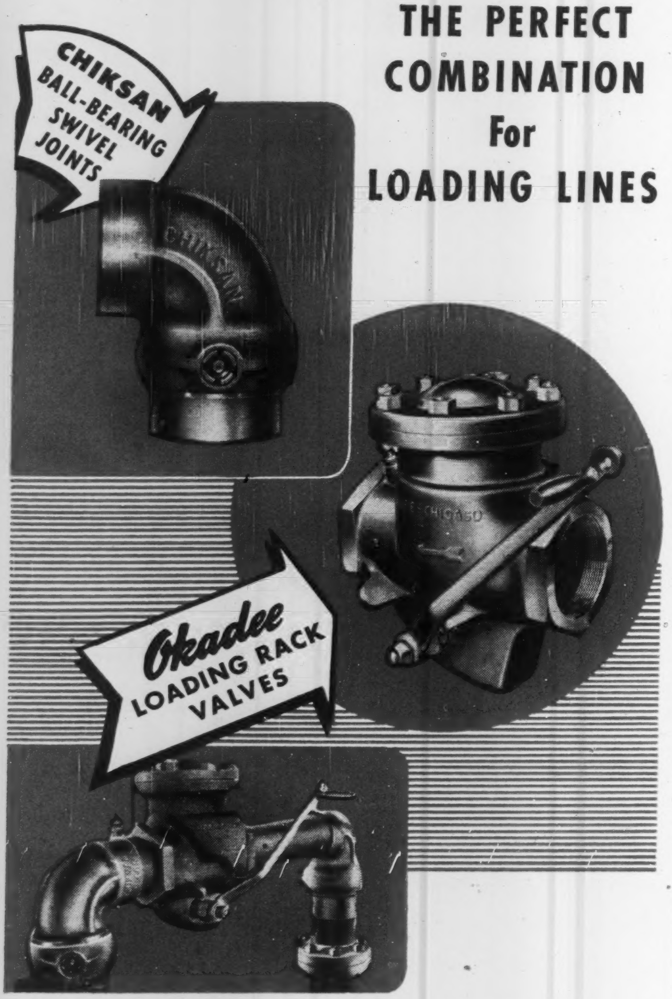
Now CHIKSAN OFFERS

THE PERFECT COMBINATION For LOADING LINES


CHIKSAN BALL-BEARING SWIVEL JOINTS
Okadee LOADING RACK VALVES
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OKADEE LOADING RACK VALVES are now distributed exclusively by Chiksan Company and Chiksan Export Company. Okadee Valves have been "working on the railroad" for 50 years . . . and serving the Petroleum Industry for a quarter-century. The combination of Chiksan and Okadee now makes possible uniformly high standards in Loading Rack design and performance.

CHIKSAN SWIVEL JOINTS have always been noted for their unobstructed inside diameter which permits full flow. Okadee Loading Rack Valves provide corresponding high capacity. In combination, they improve loading efficiency and substantially reduce loading time. Low pressure drop saves pumping costs. Non-shock closing prevents damage to equipment. Easy operation at all pressures gives the operator perfect control. Chiksan Ball-Bearing Swivel Joints provide full 360° rotation with low torque. There is nothing to tighten or adjust. You get ALL these advantages when you specify Chiksan and Okadee for Loading Rack service. Write for full details.

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see, with headquarters in Cincinnati; L. R. Farrell, formerly of the service and home office sales departments, to cover western New York state with headquarters in Buffalo; George E. Ebbeler, previously with The International Harvester Co., to cover Wyoming, Nebraska, Iowa, and central Illinois, with headquarters in the Chicago office; and L. T. Martensen, formerly with Republic Tool & Drill Co., to cover Kansas, Missouri, Oklahoma, Arkansas and southern Illinois, with headquarters in St. Louis. Most of these men will be in localities also served by distributors and will work closely with them.

◆

John H. Moss has succeeded E. R. Hardy as manager of storage battery and brake lining sales of The Goodyear Tire & Rubber Co. For the past two years Mr. Moss served as assistant manager of the department.

◆

Appointment of E. W. Heffernan as manager of the new Philadelphia sales and service office has been announced by Wheelco Instruments Co., Chicago. The office is located at 424 West Olney Ave., Philadelphia 20.

◆

Shirl M. Rudolph and William H. Pugsley have been named vice presidents in charge of sales and field research, respectively, of The Hays Corp., Michigan City, Ind., manufacturer of industrial and combustion instruments and automatic combustion controls.

◆

Expansion of its plant facilities is planned by SKF Industries Inc. to meet increased postwar demands for spherical roller bearings. As part of the expansion, the cast-iron department (which produces antifriction bearing pillow blocks) will be moved gradually to Hornell, N. Y., and the cage-stamping department to Shippensburg, Pa. Occupancy of these plants is expected to begin about July 1.

◆

To efficiently serve the West Coast, Raybestos-Manhattan Inc. has opened new offices and warehouse facilities at 131 Mission St., San Francisco 5. Adequate space is provided for a large stock of belting, hose, other industrial rubber products, and packings.

◆

According to a recent announcement, the Hyatt Bearings division of General Motors Corp. has appointed Owen B. Olson as a sales engineer in the Chicago district.

◆

Appointment of John O. Tragard as eastern regional sales manager has been announced by The Fulton Sylphon Co., Knoxville, Tenn., producer of temperature controls, bellows and bellows assemblies. Mr. Tragard will supervise territory north of Richmond, Va., and from the Atlantic seaboard west to Buffalo. His headquarters are in the Reynolds Metals Bldg. at 19 East 47th St., New York.

◆

L-K-N Co., 213 West St. Clair St., Cleveland 13, has been acquired by Charles Bruning Co. Inc., Chicago, and will be operated as the Cleveland, Bruning branch office. E. M. Elstad, who represented the Bruning Co. in the Cleveland area for the past six years, has been named branch manager. Dan N. Lynn, previously president of the L-K-N Co., will remain as special representative.

◆

Connected with Air Reduction Sales Co. since 1930, L. A. Hamilton has been named manager of the Seattle district which embraces practically the entire state of Washngton, the northern part of Idaho and the state of Montana. Formerly

Changing Flywheels to Welded Steel

BY L. C. BEATTY, PRES.
BEATTY MACHINE & MANUFACTURING CO., HAMMOND, IND.

In machining flywheel castings for our punches and shears, we occasionally ran into blow holes which necessitated scrapping of the flywheel and resulted in a loss of the machining man-hours. These unfortunate experiences led us to develop a line of welded flywheels built from homogeneous steel plate.

CUTS COST 20%

Not only have we eliminated former scrap losses, but we have cut the cost of our flywheels about 20% with the welded construction.

One of the cast iron flywheels is shown in Fig. 1. A welded flywheel is shown in Fig. 2.

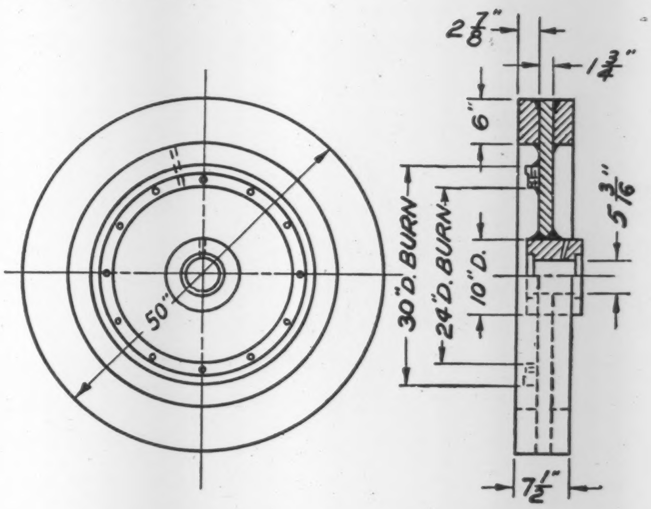

Fig. 3. Construction of welded steel flywheel.

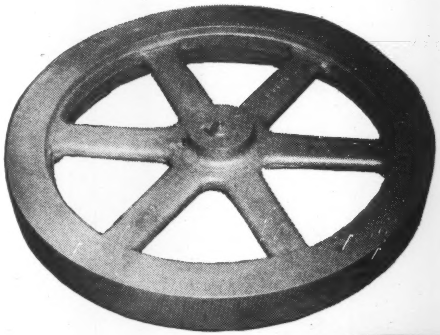

Fig. 1. Flywheel of cast iron construction used formerly.

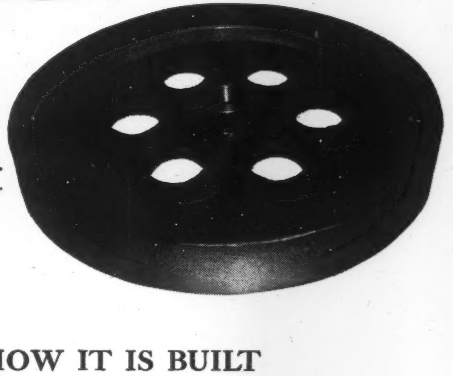

Fig. 2. A 50" welded steel flywheel after machining.

Fig. 4. Welding flywheel in fixture.

HOW IT IS BUILT

The 50" flywheel shown in Fig. 2 is built as shown in the sketch of Fig. 3. Interior fillet welds are made with the wheel in the flat position with one pass of ¼" Lincoln "Fleetweld 11" Electrode. The deep-groove welds that join the outer plates to the web are made downhand with the wheel in a motor-driven fixture as shown in Fig. 4. The grooves are filled with ¼" "Fleetweld 11".

We expect soon to install a "Lincolnweld" automatic outfit to make all of these welds. This equipment should reduce the cost of our flywheels even further.

Flywheels comprise just one of many parts for our shears and presses which we have changed over to welded steel design. In this development work we have found it helpful to have the Machine Design Studies published by Lincoln Electric. These may be obtained by writing The Lincoln Electric Company, Dept. 354, Cleveland 1. Ohio.

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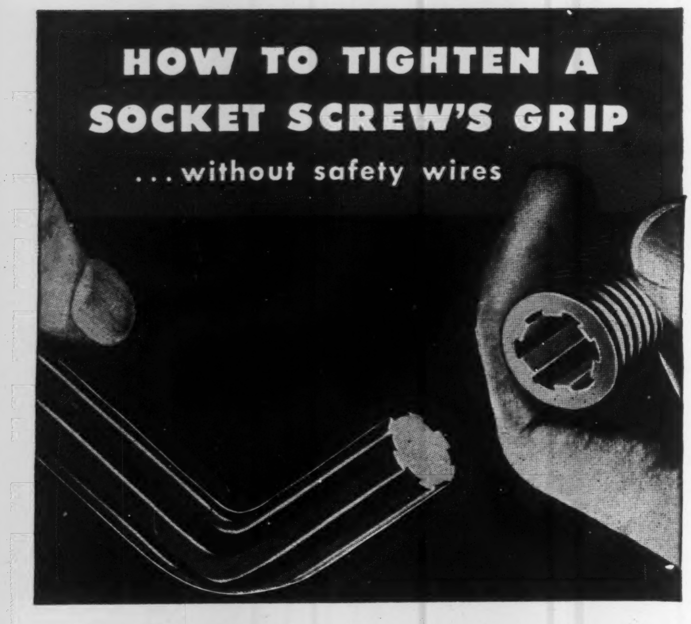
...without safety wires



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NO EXPANDING PRESSURE: THE KEY PULLS THE SCREW AROUND

BRISTO SET & CAP SCREWS

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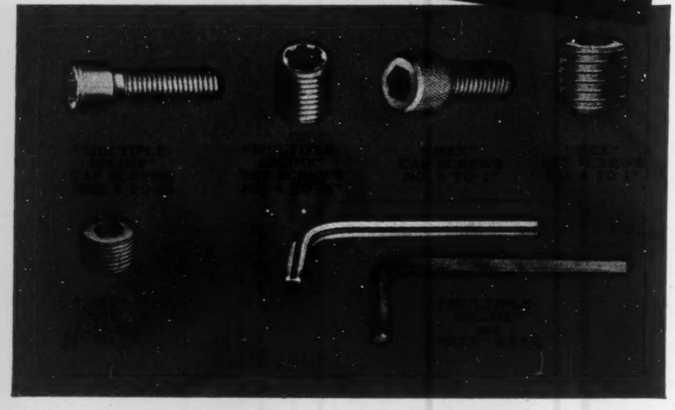


he was assistant manager of the district. Emmett W. MacCorkle Jr. has been appointed manager of the Portland district office which includes the entire state of Oregon, the southern half of Idaho, and a part of the state of Washington in the vicinity of Walla Walla. Previously he was assistant manager of the gas sales department, in the New York office. Herman Van Fleet Jr. has been named manager of the New England district which encompasses the states of Maine, Vermont, New Hampshire, Massachusetts, Rhode Island and the eastern third of Connecticut. He will also be in charge of Air Reduction plants at Boston, South Portland, Me., and Central Falls, R. I., and will make his headquarters at 122 Mt. Vernon St., Boston.

MEETINGS AND EXPOSITIONS

June 16-19—

American Society of Mechanical Engineers. Semiannual meeting to be held at Stevens Hotel, Chicago. C. E. Davies, 29 West 39th St., New York, is secretary.

June 16-20—

American Society for Testing Materials. Fiftieth annual meeting to be held at Chalfonte-Haddon Hall, Atlantic City, N. J. R. J. Painter, 1916 Race St., Philadelphia 3, is assistant to the secretary.

June 18-21—

American Society for Engineering Education. Annual meeting to be held at Nicollet Hotel, Minneapolis. F. L. Bishop, University of Pittsburgh, Pittsburgh, Pa., is secretary.

June 23-25—

American Society of Mechanical Engineers. Applied mechanics division meeting to be held at Schenectady, N. Y. Additional information may be obtained from headquarters of the society at 29 West 39th St., New York. C. E. Davies is secretary.

June 23-27—

American Electroplaters' Society. National convention to be held in conjunction with Industrial Finishing Exposition. Convention headquarters will be at Hotel Statler, Detroit, and exposition will be at Convention Hall. Additional information may be obtained from headquarters of the society at 93 Oak Grove Ave., Springfield, Mass.

Aug. 21-22—

Society of Automotive Engineers Inc. West Coast transportation and maintenance meeting to be held at Biltmore Hotel, Los Angeles. John A. C. Warner, 29 West 39th St., New York 18, is secretary and general manager.

Sept. 1-4—

American Society of Mechanical Engineers. Fall meeting to be held at Hotel Utah, Salt Lake City, Utah. C. E. Davies, 29 West 39th St., New York, is secretary.

Sept. 8-9—

American Society of Mechanical Engineers. Second national conference of industrial instruments and regulators division to be held at Chicago. Additional information may be obtained from headquarters of the society at 29 West 39th St., New York. C. E. Davies is secretary.

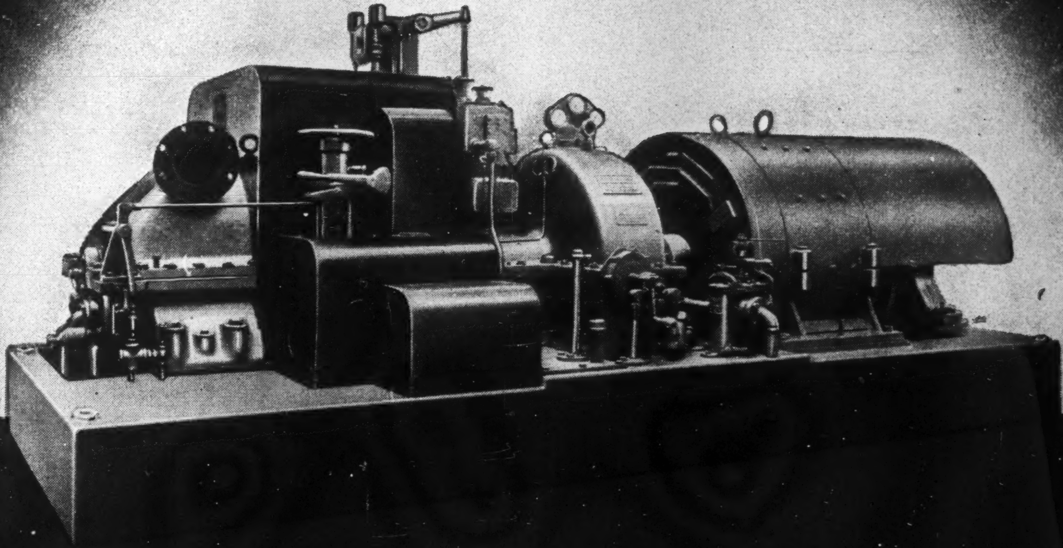
Sept. 8-12—

Instrument Society of America. Second national instrument conference and exhibit to be held at Stevens Hotel, Chicago. Richard Rimbach, 1117 Wolfendale St., Pittsburgh 12, is executive secretary.

Sept. 17-18—

Society of Automotive Engineers Inc. Tractor meeting to be held at Hotel Schroeder, Milwaukee. John A. C. Warner, 29 West 39th St., New York 18, is secretary and general manager.

A COMPACT GENERATING UNIT *of* ADVANCED DESIGN



by DE LAVAL

The obviously neat design of this compact, self-contained, multi-stage geared turbine generating unit is typical of its highly refined design throughout.

For turbines of advanced design for all services consult De Laval engineers. Representatives are located in principal cities from coast to coast.

T-4

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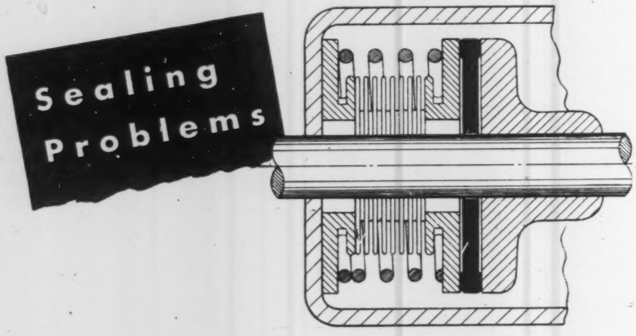
CARBON SEAL RINGS
CAN LICK *your*



Pure Carbon Seal Rings are vital to solving sealing problems. Wherever two surfaces lap together lubrication is difficult and often impossible. Under these conditions the self-lubricating, non-seizing characteristics of carbon is extremely useful.

Chemically inert with a low coefficient of expansion, these rings are highly resistant to oxidation and corrosion. Pure Carbon materials are supplied in more than 20 different grades. Each grade is made from specially developed carbon to meet one or more of the varying requirements of temperature, speed, porosity and character of material to be sealed.

Our Bulletin No. 461 describes these grades in detail, giving specific recommendations for all types of service. Write for it today.

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And the Companies Behind Them

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Self-contained furnace unit and boiler unit for use with coal or oil, for heating and humidifying. Iron Fireman Mfg. Co., Cleveland.

Business

Thermostat controlled, gas or electric pop corn machines in floor and counter models. Capacities vary from 16 to 18 oz and 12 to 13 depending on model; 50 lb raw corn per hour for gas model and 44 for electric. Star Mfg. Co. Inc., St. Louis.

Domestic

8-cu ft deluxe refrigerator, occupying same space as 6 cu ft. Other models include 6 cu ft unit with floor dimensions of a 4, and 10-cu ft with floor dimensions of an 8. General Electric Co., Bridgeport, Conn.

8-cu ft chest type freezer. Holds 280 lb of assorted frozen food. Storage space measures 39½ x 17½ x 20 in. General Electric Co., Bridgeport, Conn.

Housecleaning combination of up-right, floor-type vacuum cleaner and 6½ lb portable tank type cleaner with five attachments, General Electric Co., Bridgeport, Conn.

Food

Automatic bacon slicer and packing conveyor. Slices at 650 per min or 3000 lb per hr at 9 slices per inch on heaviest bellies. The Allbright-Nell Co., Chicago 9.

Stainless steel brewery equipment, including kettle tank, refrigeration unit, and nine storage tanks. The John Nooter Boiler Works Co., St. Louis.

Heat Treating

Recirculating air draw furnaces, for tempering and other operations at temperatures below 1200 F. Cooley Electric Mfg. Corp., Indianapolis.

Materials Handling

Heavy-duty tilting platform type power truck for massive machinery by means of integral roller-ramp and cable-draw system. The Yale & Towne Mfg. Co., Philadelphia.

4000-lb telescopic automatic fork truck for loose or bulk materials. Has drop-bottom skid dump box. Automatic Transportation Co., Chicago 20.

Metalworking

10-gage power squaring shear. Height, 47 in.; weight, 4250 lb; 5-hp motor, 85 strokes per min.; cutting length, 73 in.; back gage range, 18 in.; front, 38 in.; floor space 32 x 104 in. Parker Mfg. Co., Santa Monica, Calif.

Two large size hydraulic slotters—48 in. and 36 in. types. Ram may travel in vertical or tilted plane up to 15 degrees off vertical. Cutting and return stroke speeds are adjustable. Rockford Machine Tool Co., Rockford, Ill.

Photography

High-intensity, high-resolution power camera for x-ray diffraction work. Incorporates new slit system. North American Philips Co. Inc., New York.

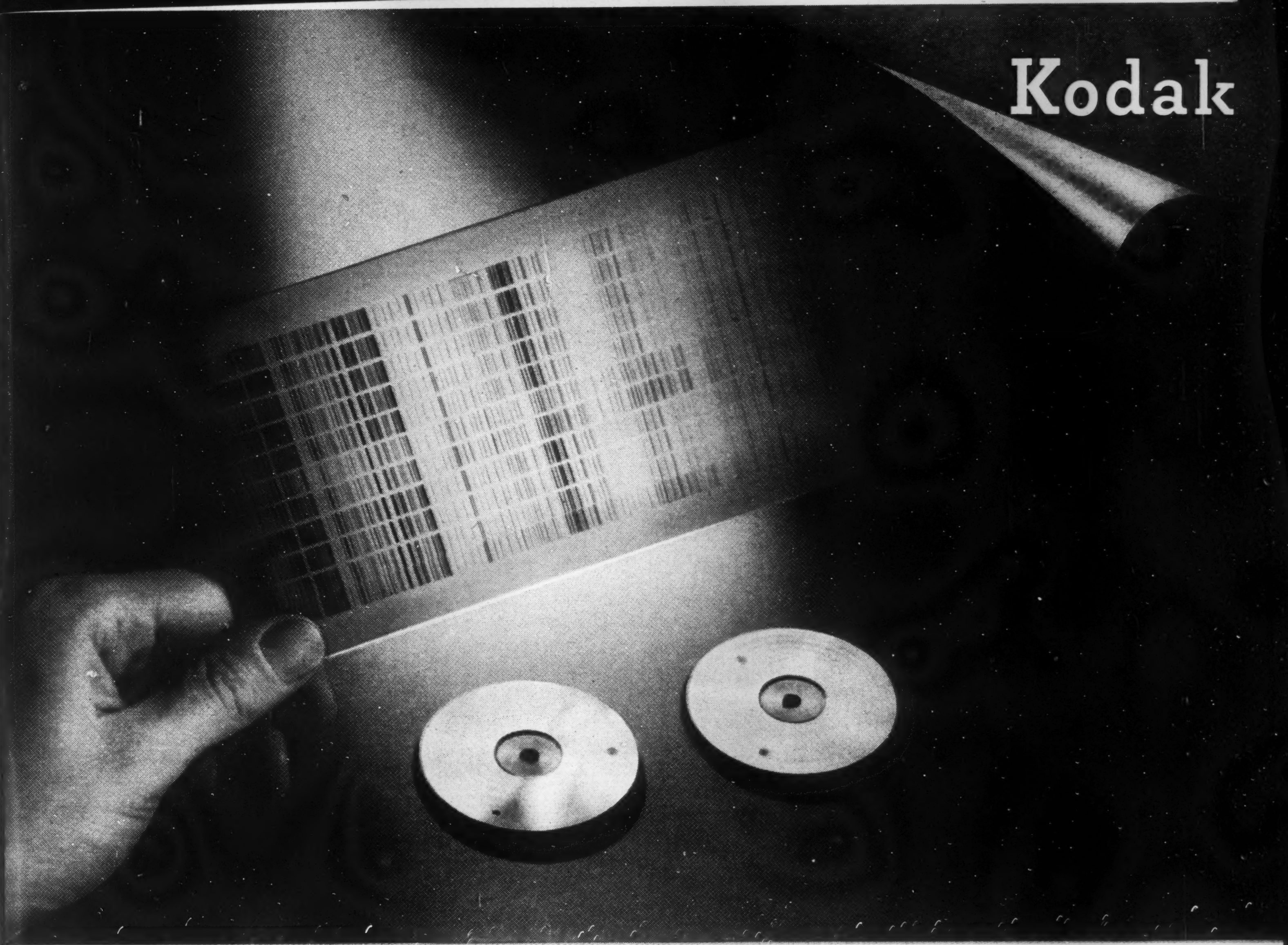
Plastics

4-oz injection molding machine and also a 100-ton compression molding press. Hydraulic Press Mfg. Co., Mt. Gilead, O.

Testing

Grain size comparator for measuring metallic grains. Provides for counting of grains in certain area or estimating their extent by comparison with a series of standard photographs. Westinghouse Electric Corp., Pittsburgh 30.

Automatic segregating instrument for rapid and accurate inspection of compression and oil piston rings. Automatically checks thickness and gap widths, and segregates rings at a rate of 2400 per hour. Sheffield Corp., Dayton, O.



This metal IS up to specification

. . . a study of its spectra showed no traces of undesirable impurities

Spectroscopy gets down to the fine points of analysis . . . quickly . . . accurately. It shows—quantitatively and qualitatively—traces of elements that are only a thousandth part of a metal, an oil, or a chemical specimen.

That is why spectroscopic analysis is one of the best quality controls. It detects, identifies, measures —in a flash . . . producing up to ten routine analyses per man-hour. It requires only the smallest test samples.

Hundreds of organizations are using spectroscopy increasingly for their research and routine testing. Checks of users show this—and costs are materially less than for older methods.

SPECTROSCOPY

another important function of photography

Chances are spectroscopy can help reduce your costs. Why not write for the Kodak book "Materials for Spectrum Analysis"? While it deals primarily with properties of plates and films for spectrography, it also contains a list of equipment manufacturers and a selected list of references.

EASTMAN KODAK COMPANY

Industrial Photographic Division, Rochester 4, N. Y.

Mail coupon for Free booklet

Eastman Kodak Company
Rochester 4, New York

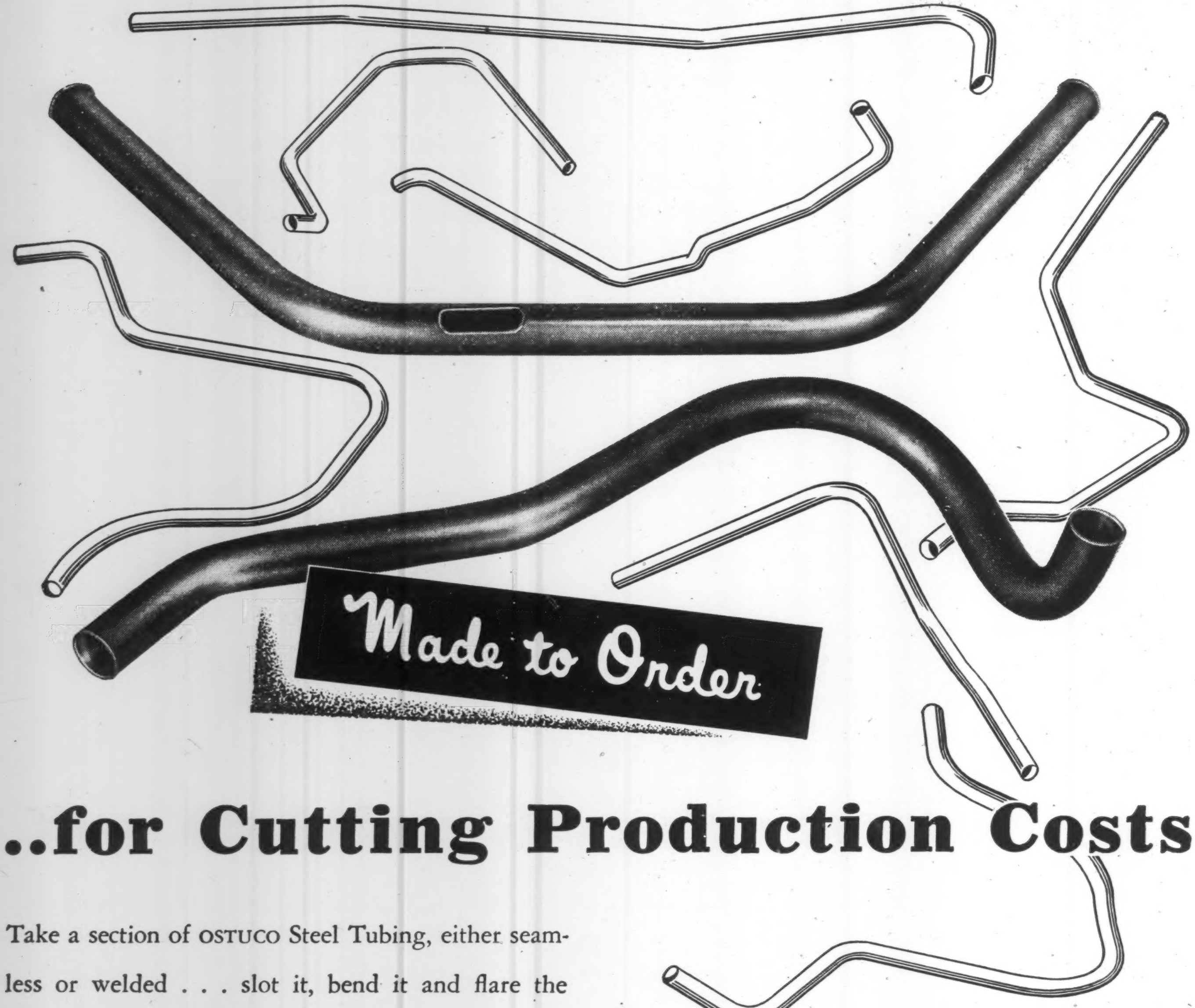
Please send me your booklet, "Materials for Spectrum Analysis."

Name______________________________
(PLEASE PRINT)

Company____________________ Dept.__________

Street______________________________

City____________________ State__________



..for Cutting Production Costs

Take a section of OSTUCO Steel Tubing, either seamless or welded . . . slot it, bend it and flare the ends and you've got a time and cost-saving solution to an involved production problem. That's because the uniform quality of OSTUCO Tubing permits forming and fabricating operations that match the most intricate specifications.

Right now, The Ohio Seamless Tube Company is producing seamless and welded steel tubing for use in products in hundreds of industries — forming and fabricating that tubing to conform exactly to customers' blueprints. Your product may be built better, at lower cost, through the use of OSTUCO Steel Tubing and the skills of OSTUCO craftsmen. The nearest sales engineer will gladly show you how and why.

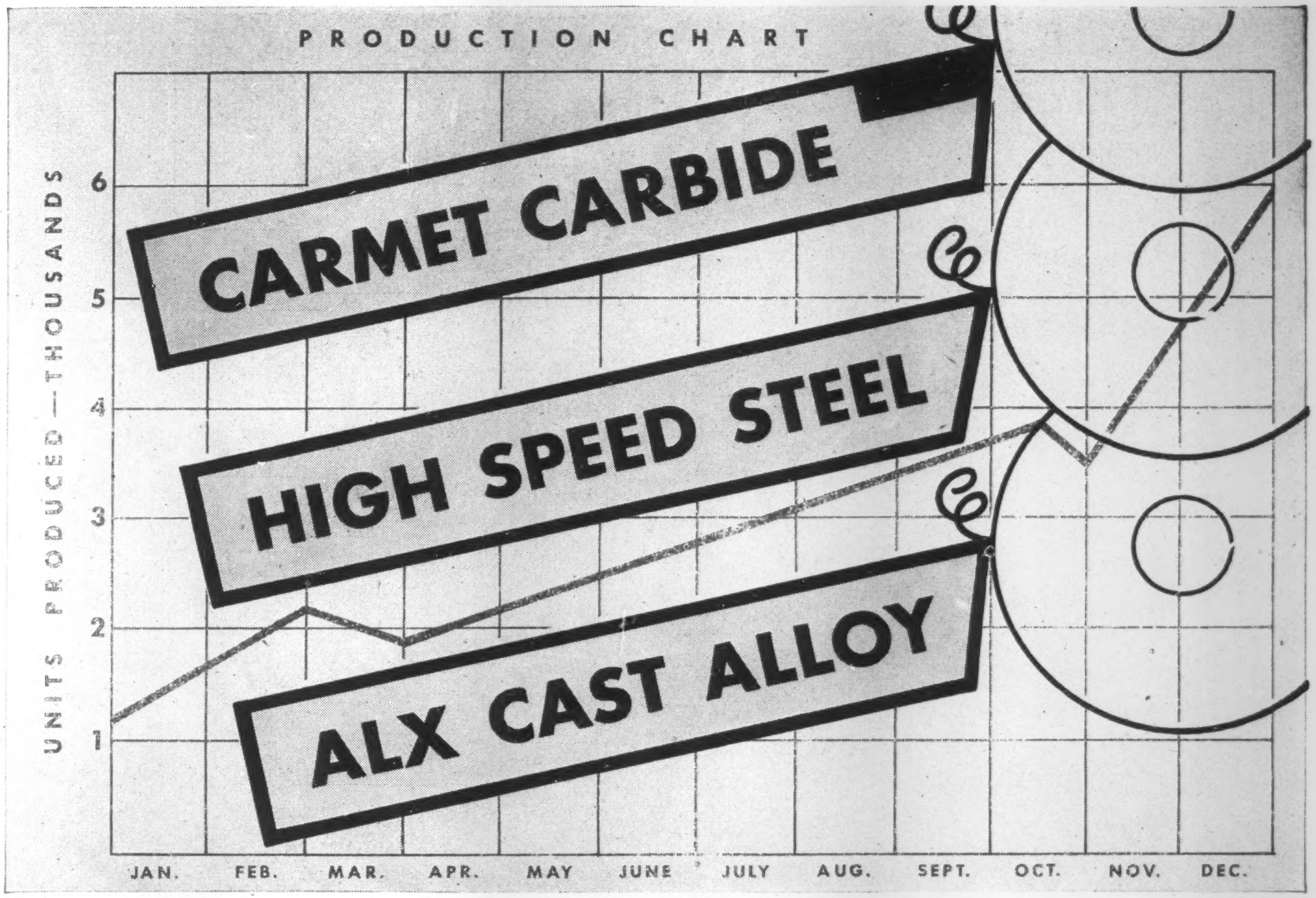
Complete information is available, without obligation, at the nearest sales office.

SHELBY OSTUCO OHIO

THE OHIO SEAMLESS TUBE COMPANY

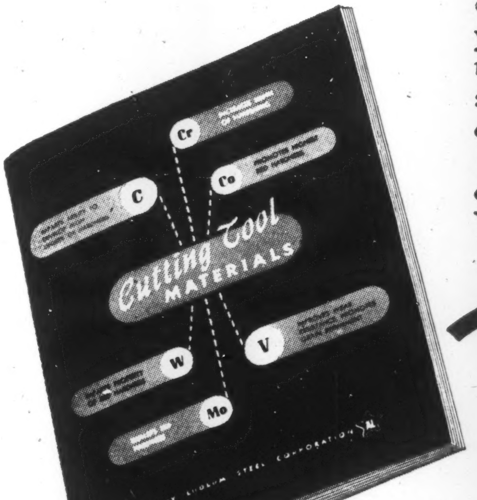
Plant and General Offices: SHELBY, OHIO

SALES OFFICES: CHICAGO, Civic Opera Bldg., 20 North Wacker Dr. CLEVELAND, 1328 Citizens Bldg. • DETROIT, 2857 E. Grand Blvd. HOUSTON, 927 A M & M Bldg. • LOS ANGELES, Suite 200-170 So. Beverly Drive, Beverly Hills • MOLINE, 309½—16th St. • NEW YORK, 70 East 45th St. • PHILADELPHIA, 123 S. Broad St. • ST. LOUIS, 1230 North Main St. • SEATTLE, 3205 Smith Tower • SYRACUSE, 501 Roberts Ave. • TULSA, Refinery Engr. & Equip. Co., 604 Ten E. 4th St. Bldg. • CANADIAN REPRESENTATIVE: Railway & Power Corp., Ltd., HAMILTON, MONTREAL, NORANDA, NORTH BAY, TORONTO, VANCOUVER and WINNIPEG.


PRODUCTION CHART
UNITS PRODUCED—THOUSANDS
6
5
4
3
2
1
CARMET CARBIDE
HIGH SPEED STEEL
ALX CAST ALLOY
JAN.
FEB.
MAR.
APR.
MAY
JUNE
JULY
AUG.
SEPT.
OCT.
NOV.
DEC.

Which CUTTING TOOL MATERIAL WILL DO *Each* OF YOUR JOBS *Best*?

Allegheny Ludlum offers you—*from one source*—a choice of *every* type of cutting material . . . each in a wide and complete range of grades and sizes. That means a better opportunity for you to pick the tools *best* suited to each of your production jobs—with resultant savings in production time and costs. There's real value for you in one source for all your cutting tool requirements, plus a competent Mill Service Staff to assist your selection. ● Write today—on your company letterhead, please—for our new, full-color booklet on "Cutting Tool Materials." You'll find it a big help in your production plans.


Cutting Tool
MATERIALS
C
Cr
Co
W
V
Mo

SEND
FOR
THIS
NEW
BOOK

ADDRESS DEPT. MD-54

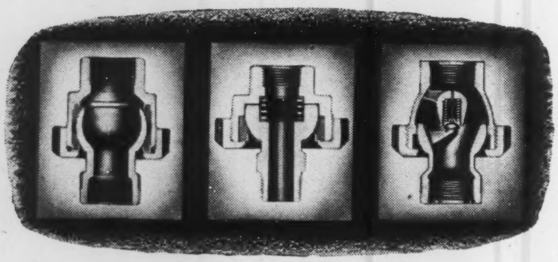
ALLEGHENY
LUDLUM
STEEL CORPORATION • Pittsburgh, Pa.

AL

Fine Tool Steels
Since 1854

W&D 994

Boxing Gloves for Fuel Lines

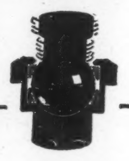


Barco Flexible Joints are like boxing gloves—they cushion shock and impact. The best way to protect fuel lines from vibration in mechanical operation is with this famous flexible joint. In every phase of industrial activity, these expertly engineered protectors have successfully offset the onslaught of shock and vibration in fuel lines, guarded against strains caused by contraction and expansion. For full particulars about this universally accepted line, write to Barco Manufacturing Company, Not Inc., 1806 Winnemac Avenue, Chicago 40, Illinois.

BARCO FLEXIBLE JOINTS

FREE ENTERPRISE—THE CORNERSTONE OF AMERICAN PROSPERITY

Not just a swivel joint ...but a combination of a swivel and ball joint with rotary motion and responsive movement through every angle.



In Canada: The Holden Co., Ltd., Montreal, Canada.

"MOVE IN EVERY DIRECTION"

The help we give you HERE will save you money HERE

While the designs for aluminum die castings you'll need months from now are still sketches on the drawing board . . . *this* is the time to call in the Alcoa die castings experts. They can help you get all the benefits of strength and light weight from aluminum die castings. They can show you how to simplify designs to reduce costs of parts.

Our engineers will be glad to discuss your die castings problems with you. Write to ALUMINUM COMPANY OF AMERICA, 1940 Gulf Building, Pittsburgh 19, Pennsylvania. Sales offices in leading cities.

MORE people . . . want MORE aluminum . . . for MORE uses than ever

ALCOA FIRST IN ALUMINUM

IN EVERY COMMERCIAL FORM

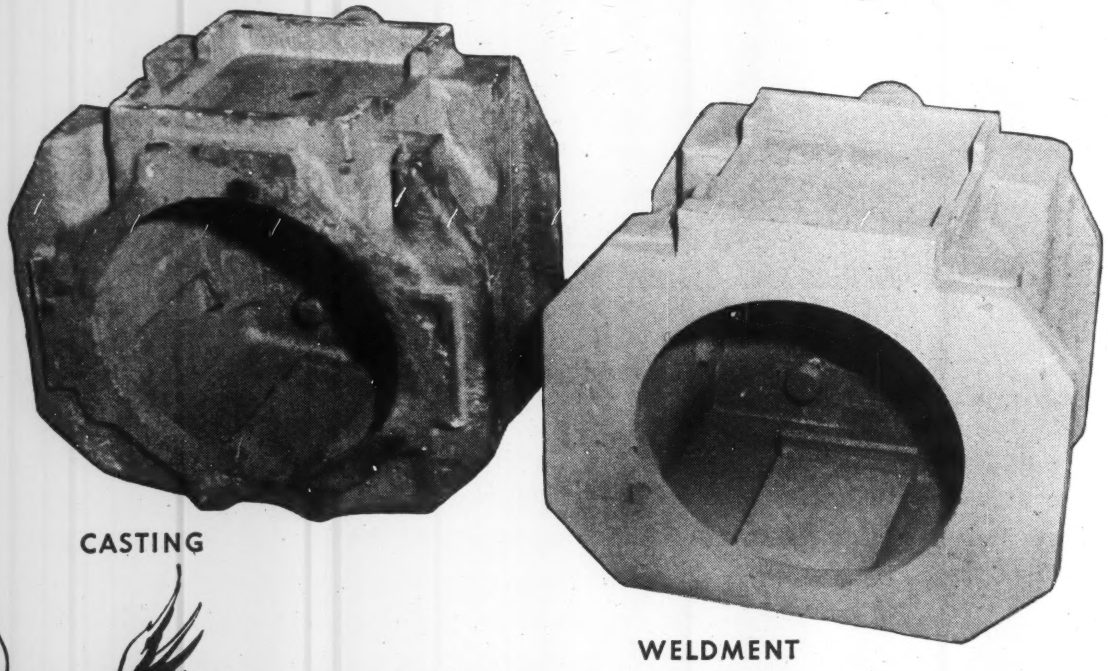
WELDMENTS

by AMERICAN WELDING

● Designed to give the most advantageous distribution of material over the cross section, this weldment replaces a casting and saves 93 pounds. Machining time is appreciably reduced by the balanced design which permits fabrication to relatively close tolerances.

Our engineers are familiar with all types of manual or automatic electric arc, gas, and resistance welding. We are confident that our representatives can show you where our facilities can be of service to you in meeting cost and weight problems. Write for our illustrated catalogues.

37% Saving in Weight



THE AMERICAN WELDING
AND MANUFACTURING COMPANY
3000 GRISWOLD ST. • WARREN, OHIO

FOR ALL MACHINERY MANUFACTURERS

THE KAYDON ENGINEERING CORP.
MUSKEGON · MICHIGAN

Millions

of KAYDON *precision needle rollers

*Tolerance on diameter .0002″. On the Inspection Board shown above are **KAYDON** Needle Rollers .1250″ diameter.

The success of **KAYDON** Precision NEEDLE ROLLERS in automobile and truck transmissions, universal joints, clutches, steering gears and other products, has led to their use in practically all types of machinery.

Since these needle rollers may be used between hardened shafts and hardened bores of housings or gears, they eliminate the need for bearing races. Thus they provide the most compact high-capacity anti-friction bearing possible, requiring little or no more space than so-called plain or "solid" bearings.

Millions of these precision needle rollers are being made in standard sizes, 1/16″ to 5/16″ diameters (tolerance .0002″ on diameter), flat or rounded ends. Other sizes are being added as "standard" when quantities warrant.

By using standard sizes that are now in big volume production, you get the benefit of low cost for highest performance-proved quality in small or large quantities . . . but regardless of whether your machine design permits use of standard sizes or demands special needle rollers, contact **KAYDON.**

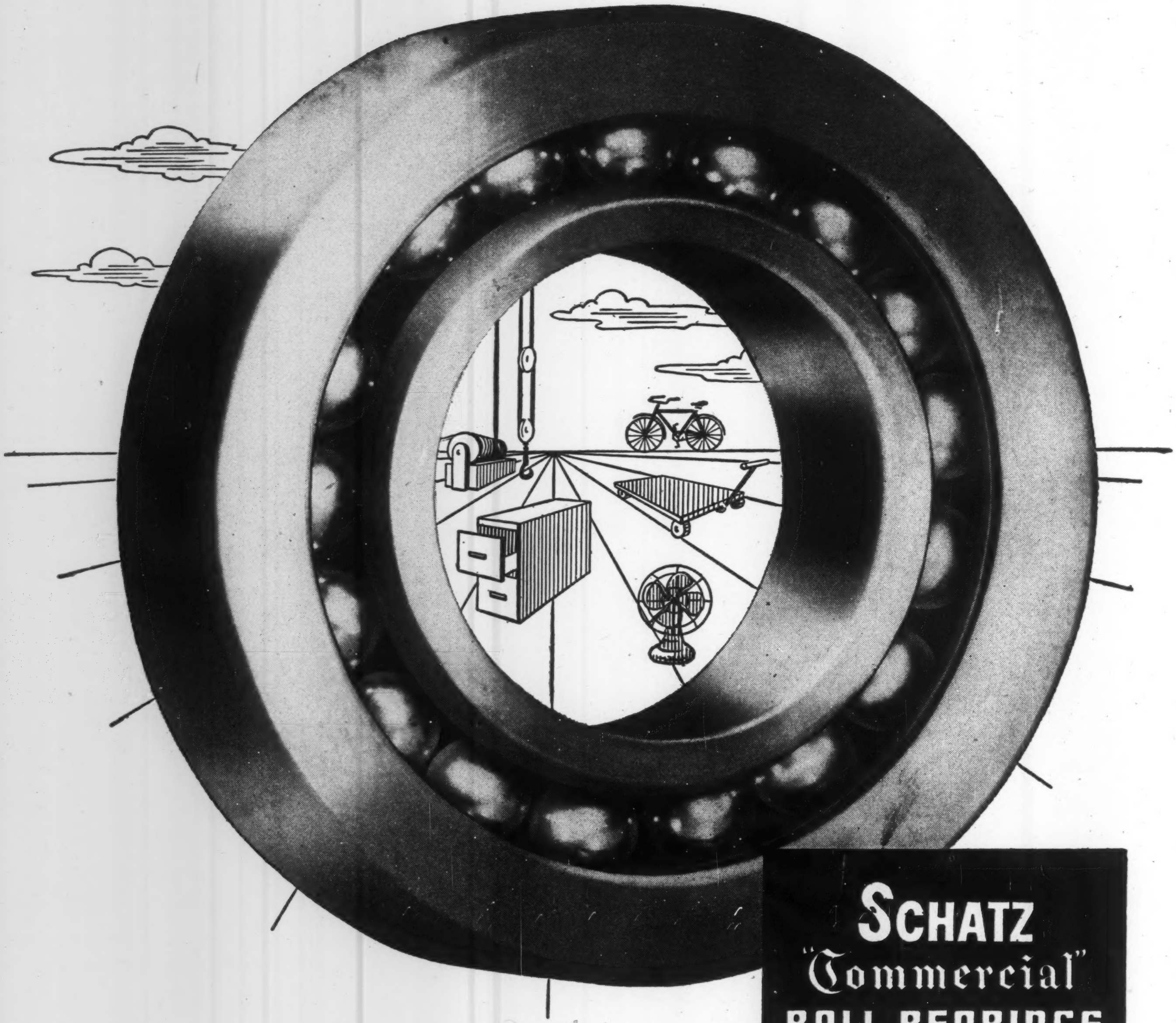
Be sure to state sizes and quantities when you send your inquiries.

Capacity also available now for all types and sizes of **KAYDON** Standard or Special Bearings. It pays to "contact **KAYDON** of Muskegon."

KAYDON *Types of Standard or Special Bearings:*
Spherical Roller • Taper Roller • Ball Radial
Ball Thrust • Roller Radial • Roller Thrust

THE KAYDON ENGINEERING CORP., MUSKEGON, MICH.

All types of Ball and Roller Bearings 4″ bore to 120″ outside diameter



SCHATZ
"Commercial"
BALL BEARINGS

The low-cost, multi-purpose ball bearing

You name the product...hand truck, electric fan, file cabinet, bicycle, or *any* application where friction-free operation must be combined with low initial cost. That's the job for Schatz "Commercial" Ball Bearings.

How do "Commercials" differ from other low cost ball bearings? High-grade, low-carbon, cold-rolled steel rings is one way. Through-hardened precision balls is another. The combination strengthens their capacity to take on the heavier loads, and results in longer bearing life and all-around utility...whatever the service requirements.

"Commercial" Ball Bearings are manufactured in every standard type and size. The common denominator in each is the half-century of Schatz manufacturing experience, plus the engineering counsel that's ready to lend a knowing hand in fitting the right bearing to your problem.

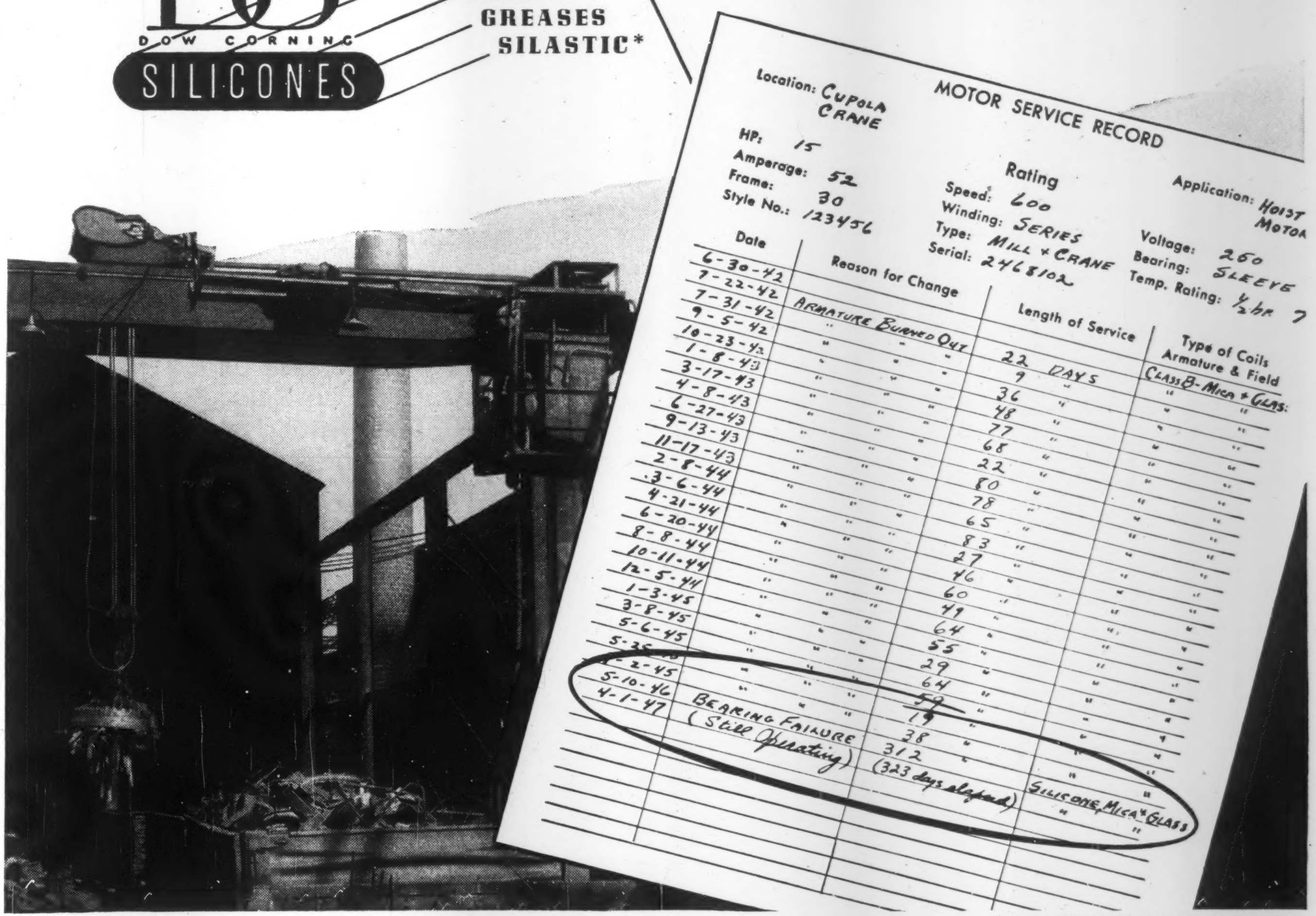
Remember, Schatz makes only ball bearings, and "Commercials" are manufactured only by Schatz.

THE SCHATZ MANUFACTURING COMPANY
POUGHKEEPSIE, NEW YORK
REPRESENTATIVES LOCATED AT
Detroit: 2640 Book Tower—26 • Cleveland: 402 Swetland Building—15
Chicago: 8 S. Michigan Ave.—3 • Los Angeles: 5410 Wilshire Blvd.—36

DC
DOW CORNING
SILICONES

VARNISHES
RESINS
FLUIDS
GREASES
SILASTIC*

withstand heat • exclude moisture • resist oxidation



MOTOR SERVICE RECORD

Location: CUPOLA CRANE
HP: 15
Amperage: 52
Frame: 30
Style No.: 123456

Rating
Speed: 600
Winding: SERIES
Type: MILL & CRANE
Serial: 2468102

Application: HOIST MOTOR
Voltage: 250
Bearing: SLEEVE
Temp. Rating: ½ hr 7

Date	Reason for Change	Length of Service	Type of Coils Armature & Field
6-30-42			
7-22-42	ARMATURE BURNED OUT	22 DAYS	CLASS B-MICA & GLASS
7-31-42	" " "	9 "	" "
9-5-42	" " "	36 "	" "
10-23-42	" " "	48 "	" "
1-8-43	" " "	77 "	" "
3-17-43	" " "	68 "	" "
4-8-43	" " "	22 "	" "
6-27-43	" " "	80 "	" "
9-13-43	" " "	78 "	" "
11-17-43	" " "	65 "	" "
2-8-44	" " "	83 "	" "
3-6-44	" " "	27 "	" "
4-21-44	" " "	46 "	" "
6-20-44	" " "	60 "	" "
8-8-44	" " "	49 "	" "
10-11-44	" " "	64 "	" "
12-5-44	" " "	55 "	" "
1-3-45	" " "	29 "	" "
3-8-45	" " "	64 "	" "
5-6-45	" " "	~~59~~ "	" "
5-3[illegible]	" " "	19 "	" "
[illegible]-2-45	" " "	38 "	" "
5-10-46	BEARING FAILURE	312 "	SILICONE, MICA & GLASS
4-1-47	(Still Operating)	(323 days elapsed)	" "

SERVICE RECORD COURTESY NATIONAL ELECTRIC COIL CO.

DC SILICONE INSULATION

CUTS MOTOR FAILURE 90%!

A cupola crane motor used to unload scrap in a large steel mill was designed for intermittent service. But steel hungry America kept it working full time to meet war and postwar requirements. Insulated with the best Class 'B' materials, this motor failed 22 times in about three years, giving an average service life of only 50 days.

Design limitations made it impossible to install a larger motor. Lost time, costly rewinding, and heavy maintenance expense seemed inescapable—until DC Silicone Insulation was introduced by Dow Corning.

National Electric Coil Co., of Columbus, Ohio, was one of the first to realize the advantages of Silicone-glass-mica insulation. Their engineers redesigned the coils of that motor, using Silicone Insulation—DC 996 Varnish with glass and mica.

Then it operated almost continuously for 312 days—six times the average life with Class 'B' insulation—before a bearing failed, causing mechanical failure of the insulation. The motor was again rewound with Silicone Insulation and was still running April 1, 1947—after 323 days!

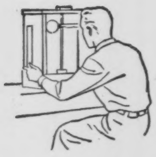
DC Silicone Insulation will keep hard-working motors running at least 10 times as long as Class 'B' insulation. That's proved by three years of tough tests and field service. DC 996 is further described in leaflet No. B 3-8.

*TRADE MARK, DOW CORNING CORPORATION

DOW CORNING CORPORATION • MIDLAND, MICHIGAN
New York • Chicago • Cleveland • Los Angeles
In Canada: Fiberglas Canada, Ltd., Toronto
In England: Albright and Wilson, Ltd., London

Dow Corning
FIRST IN SILICONES

Matched for weight and matched for strength

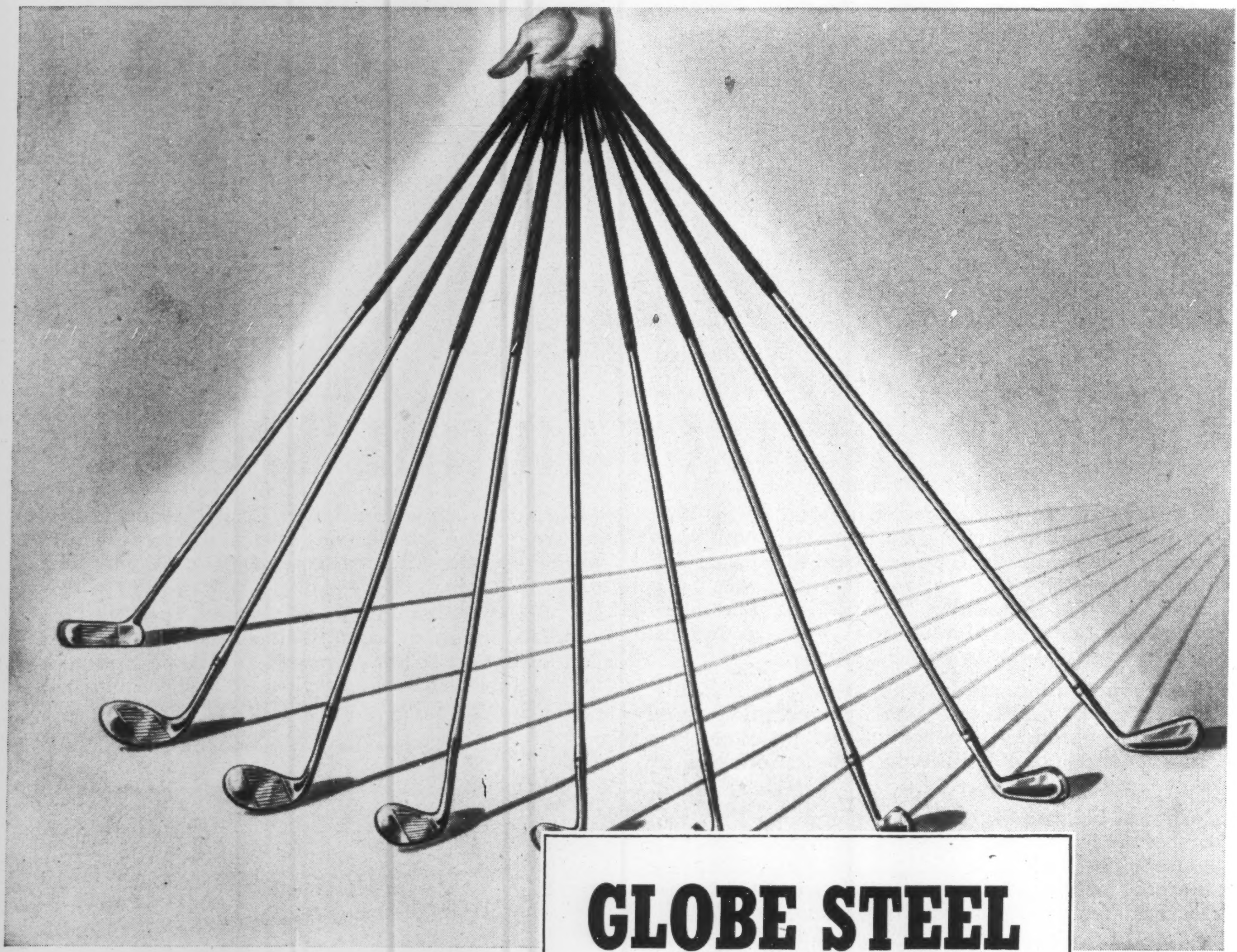


Can you ever forget the fun of using your matched "clubs" for the first time; the thrill that comes each time you swing and feel and hear that solid click peculiar to a shot that's "in the groove". But don't overlook the fact that the shafts of matched clubs are steel tubes. For only with steel tubes can you get the uniformity in strength and weight—(plus economy of manufacture) that makes matched clubs possible.

Globe Steel Tubes Co. does not make matched golf clubs—our business is steel tubes in seamless carbon, alloy, stainless steels — high purity ingot iron tubing known as Globeiron — and welded stainless steel tubing called Gloweld. And in that business we exercise every precaution and care known to chemistry, physics and metallurgy to produce tubing "matched" in unvarying uniformity and quality. A fully equipped and staffed Globe laboratory helps to make that possible.

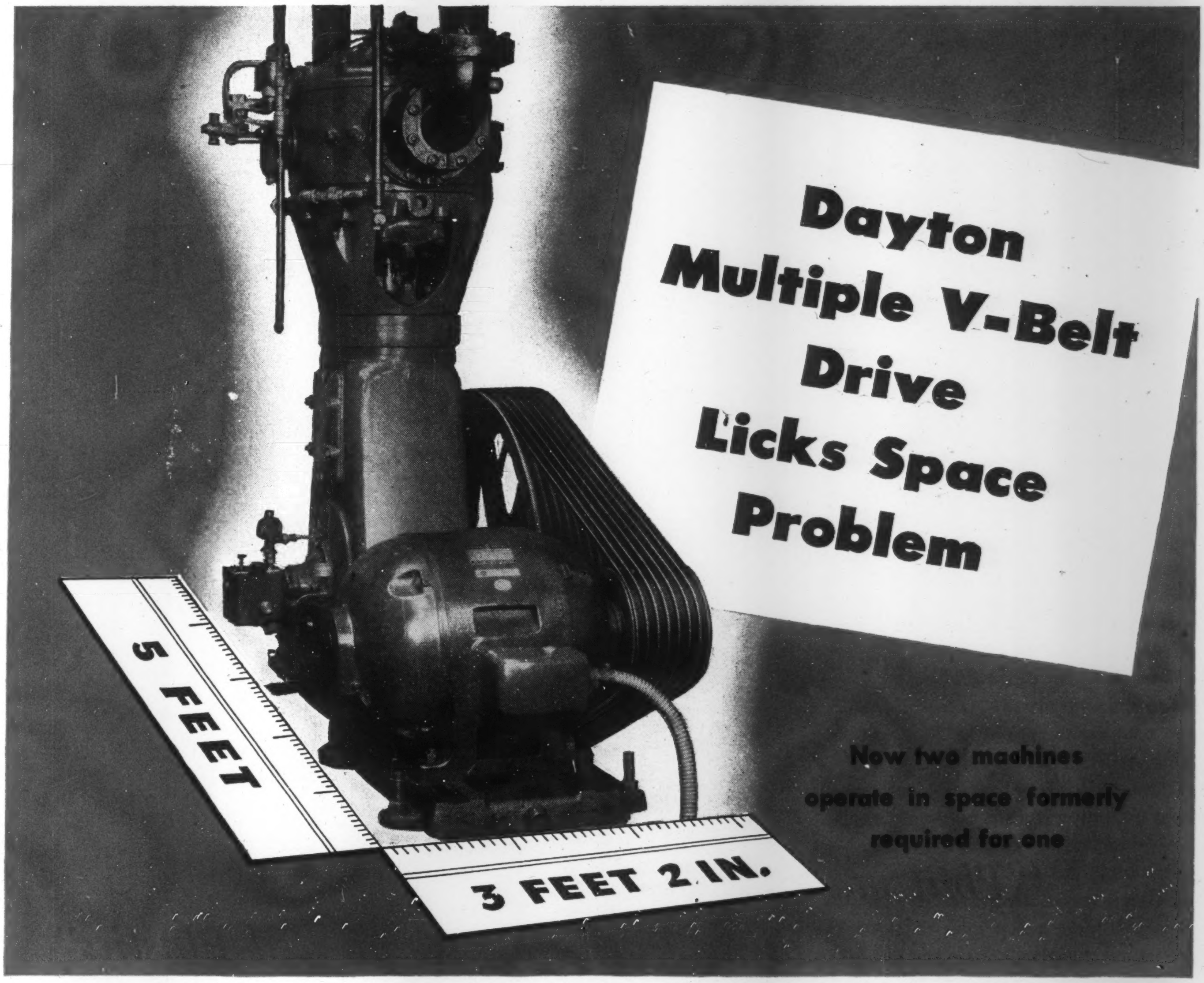
Your requirements in steel tubing may be just "staples" — or they may involve problems. In either case you can look to Globe as a dependable source of supply as well as a highly specialized organization eager to explore new fields in tubes and tubing applications.

Globe Steel Tubes Co. • Milwaukee 4, Wisconsin



Seamless Tubes—Carbon—Alloy—Stainless Steels—Welded Stainless Steel Tubing—Gloweld—High Purity Ingot Iron Seamless Tubes—Globeiron Mechanical Tubing—Pressure Tubing—Tubing for Corrosion and Heat Resisting Applications.

GLOBE STEEL
Tubes


Dayton
Multiple V-Belt
Drive
Licks Space
Problem
5 FEET
3 FEET 2 IN.
Now two machines
operate in space formerly
required for one

Here is one of the latest model vertical air compressors specifically designed for continuous, heavy-duty, 24-hour per day service. One of its chief advantages is the small floor space it requires. Yet its efficiency demands consistent, dependable power. To develop the power needed, the designer specified a Dayton V-Belt Drive.

This is another outstanding example of the flexibility of Dayton V-Belt Drives. And the ability of Dayton V-Belts to perform in excess of standard requirements under all operating conditions . . . unaffected by dust, oil, heat, liquids . . . is another of the many reasons why more industrial designers consistently specify Daytons for original equipment.

A Dayton Power Transmission Specialist is ready to help you. Call or write:

DAYTON RUBBER • DAYTON, OHIO

POWER
Dayton
V-BELT DRIVES

NOW! **Rayon Cords*

PROVIDE DAYTON V-BELTS WITH

1. Minimum Stretch 2. Greater Flex Strength
3. Longer V-Belt Life

* Rayon cords are *specially processed* by Dayton for use in V-Belts to provide the most efficient and economical power transmission service for your machine needs. For the complete story write for booklet A-469.

Dayton Rubber

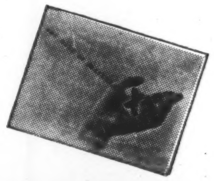
THE MARK OF TECHNICAL EXCELLENCE IN NATURAL AND SYNTHETIC RUBBER

THE WORLD'S LARGEST MANUFACTURER OF V-BELTS

"That makes sense—
using Fiberglas-Reinforced Plastics"*

T-36 Fiberglas mat is *low in cost* and is used advantageously with *high-pressure laminating equipment* . . . This may be the answer to some of your problems. If you are designing, manufacturing or need products which require high impact strength, low moisture absorption, dimensional stability, high temperature resistance, corrosion resistance, good electrical qualities—find out about Fiberglas T-36 mat as a reinforcement for high-pressure resins . . . This product is also well adapted to new, high-speed, low-pressure molding processes.

WRITE FOR SAMPLE OF T-36 MAT AND NEW BOOKLET which describes the various forms of Fiberglas reinforcing materials and illustrates the new quantity production methods. Write: Owens-Corning Fiberglas Corporation, Dept. 808, Toledo 1, Ohio. Branches in principal cities.



In Canada: Fiberglas Canada Ltd., Toronto 1, Ontario.

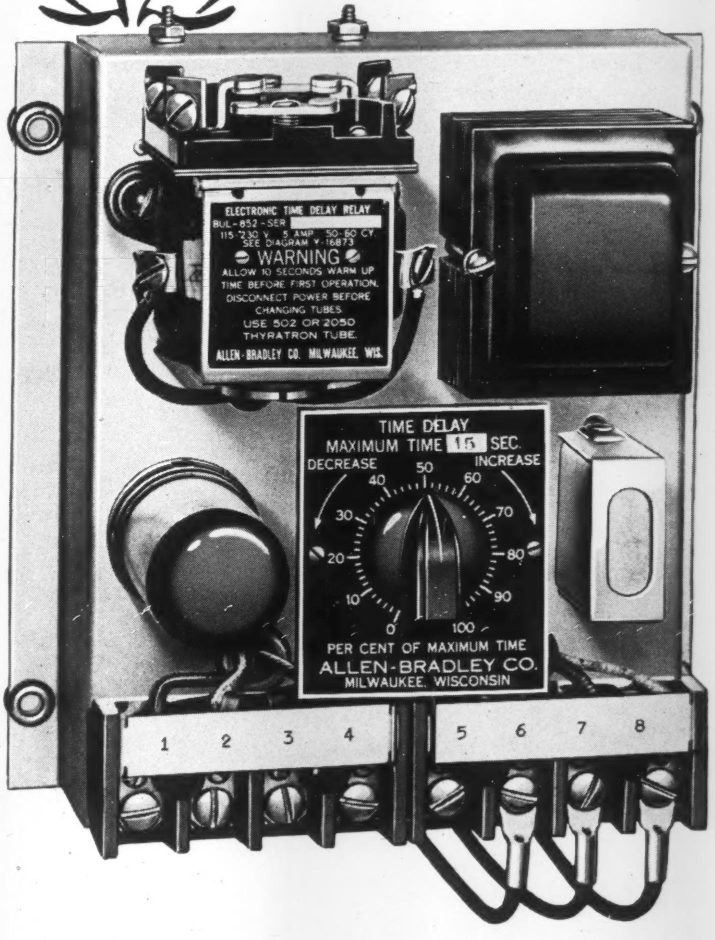
OWENS-CORNING
FIBERGLAS
T.M. REG. U.S. PAT. OFF.

FIBERS • MATS • CLOTHS

*FIBERGLAS is the trade name (Reg. U. S. Pat. Off.) of a variety of products made of or with glass fibers by Owens-Corning Fiberglas Corporation.

New Bulletin #852

ELECTRONIC TIMING RELAY


ELECTRONIC TIME DELAY RELAY
BUL-852-SER
115-230 V. 5 AMP. 50-60 CY.
SEE DIAGRAM Y-16873
WARNING
ALLOW 10 SECONDS WARM UP TIME BEFORE FIRST OPERATION.
DISCONNECT POWER BEFORE CHANGING TUBES.
USE 502 OR 2050 THYRATRON TUBE.
ALLEN-BRADLEY CO. MILWAUKEE, WIS.
TIME DELAY
MAXIMUM TIME 15 SEC.
DECREASE
INCREASE
0
10
20
30
40
50
60
70
80
90
100
PER CENT OF MAXIMUM TIME
ALLEN-BRADLEY CO.
MILWAUKEE, WISCONSIN
1
2
3
4
5
6
7
8

A Rugged Timer that Provides Accuracy under Frequent Service

This new Allen-Bradley electronic timing relay is designed primarily for machine tool and other applications where an accurate timer is required for frequent service. It has a range of 20 to 1, and is provided in eight timing ranges, with from one-half second up to two minutes maximum time delay. The reset time is approximately 1/10 of the maximum time delay.

The new Bulletin 852 A.C. Timing Relay possesses a high degree of flexibility. It can be recycled rapidly over long periods without affecting its performance in any way. The relay can be furnished with two normally open contacts, two normally closed contacts, or with one normally open contact and one normally closed contact. Write for complete information, Allen-Bradley Co., 1316 S. Second St., Milwaukee 4, Wis.

RELIABLE—Timing is always consistent because the operation of this relay is electronically controlled and does not depend upon any mechanical action.

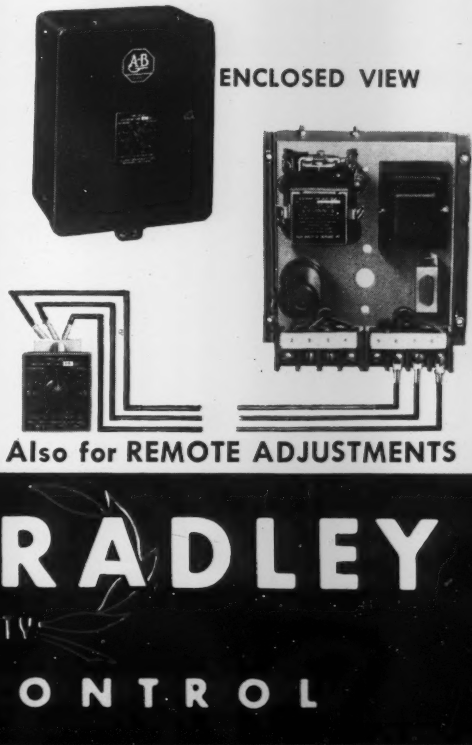
EASY ADJUSTMENT—Timing is adjusted by a simple turn of a knob to the desired calibration. The relay will always reset to this adjustment.

UNAFFECTED BY VOLTAGE—Line voltage changes of 10% or less have no effect on the timing operation.

REMOTE ADJUSTMENT—Timing control potentiometer and dial may be removed as a unit and mounted separately for control from a distance.

INDUSTRIAL RELAY—A rugged A-B industrial type solenoid relay is used for switching, eliminating a common source of electronic timing relay trouble.

VIBRATION-PROOF—The chassis has rubber mountings which isolate the relay from vibration and shock.


ENCLOSED VIEW
A-B

Also for REMOTE ADJUSTMENTS

A-B Quality

ALLEN-BRADLEY

QUALITY

MOTOR CONTROL

THREE OTHER RELIABLE ALLEN-BRADLEY TIMING RELAYS

ALLEN-BRADLEY BULLETIN 848 TIMING RELAY
ADJUSTMENT
TO CHANGE TIME SETTING OF RELAY REMOVE DASHPOT FROM RELAY FRAME
SCREW CORE UP TO OBTAIN SHORTER TIMING
SCREW CORE DOWN TO OBTAIN LONGER TIMING
Allen-Bradley Co.
TIMING

Bulletin 848
FLUID DASHPOT TIMING RELAY

This magnetic type relay is simple, dependable in operation, and inexpensive. It can be used in many applications where reliability is more important than exactness of timing. With the new dashpot fluid used in this relay, operation at ambient temperatures from + 120F to —30F is possible without undue variations in timing. Has an adjustable range from 2 to 20 seconds. Available for a-c or d-c, in single-pole construction with either normally open or normally closed contacts.

A-B
QUALITY
TIME
DECREASE
INCREASE

Bulletin 849
PNEUMATIC TIMING RELAY

This solenoid type timing relay utilizes an adjustable pneumatic dashpot for controlling the tripping time. It has a range of from 1/6 second to 180 seconds and an accuracy of approximately ± 10%. While it has neither the accuracy nor the long timing range of a motor-driven timer, it is extremely reliable, and will give unusually good performance in timing most production cycles and similar machine tool applications. The relay is designed for 25 to 60 cycle operation, and has a single-pole, double throw switch.

BULLETIN 850
TYPE
ALLEN-BRADLEY CO.
NO
NC

Bulletin 850
MOTOR-DRIVEN TIMING RELAY

Designed for timing comparatively long intervals with a high degree of accuracy. Can be furnished in several ranges with maximum time delays of from 1 to 15 minutes. Variations in time between successive operations are less than 1% of the full scale range. For a-c pilot control service only. The single-pole switch can be connected for normally closed or normally open operation. Provides excellent service where high speed recycling is not required.

Allen-Bradley
Fluid Dashpot Timing Relay

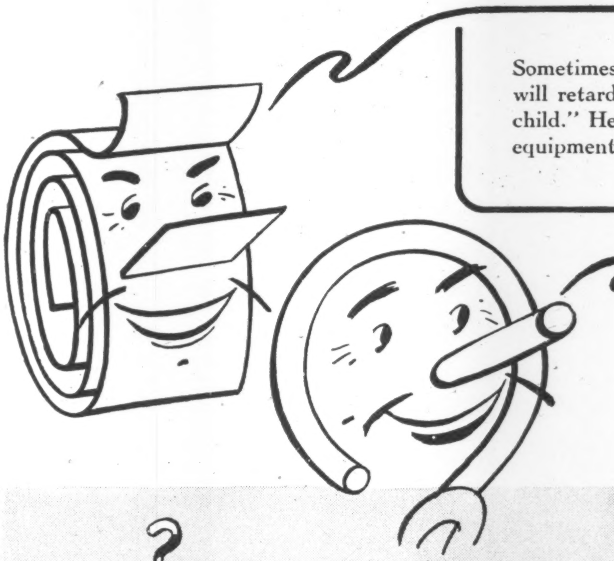
WRITE FOR DESCRIPTIVE BULLETINS

Allen-Bradley Co., 1316 S. Second St., Milwaukee 4, Wis.

ALLEN-BRADLEY

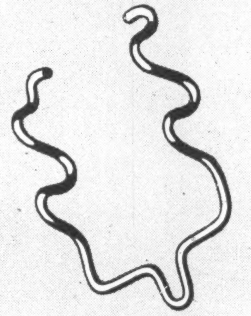
MOTOR CONTROL

WICK AND SPEN *Coil Clinic*
CAN CURE YOUR BRAIN CHILD'S HEADACHES



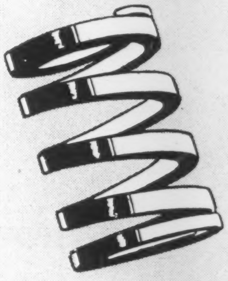
Sometimes a little spring can cause headaches that will retard the development of a designer's "brain child." Here, at Coil Clinic, we have the operating equipment for curing such cases.

The cases brought to our clinic are given a thorough check-up by skilled technicians. They make laboratory tests, supervise forming operations, give heat treatments and build springs with plenty of muscle. Here are several of the 50,000 cases where the operations have been successful.



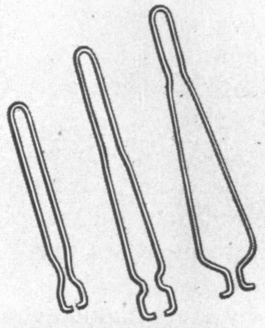
CASE No. 32803

By developing "U" shaped bends in the sides of this form, which is used as a box cover locking clamp, the strain is transferred from pure tension to a bending action. Clamping action is easy and positive. Because of our manufacturing know-how, production costs for this item are reasonable.



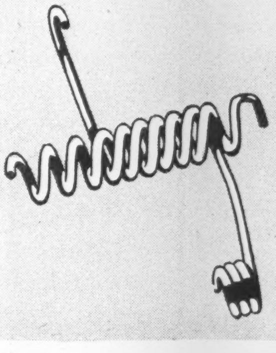
CASE No. 39673

The load-carrying capacity of this spring was increased 20° by using square wire. But the flexibility is only 70° of that of round wire of the same size. Such designs are used on machine tools, in die sets, and other applications where space limitations present a problem.



CASES No. 43610, 43612 and 43876

These wire forms are supplied for assembly with various colorful plastic pieces to make hair-do barrettes. By designing special forming tools, automatic production is entirely practical and quantity costs are very low.



CASES No. 39255 and 39889

These springs function as threaded machine parts. They are used in a household gas meter and, in case of back pressure, prevent the meter from registering in reverse. The forms were developed to meet an operating idea submitted to us.

THIS FREE BOOK MAY SAVE YOU MONEY

Our book, "Springs and Wire Forms" gives valuable data relating to spring performance, technical information, formulae and tables needed to help in proper spring selection. Write today for your free copy. Remember too, that our engineers are at your service in designing any conceivable type of springs. We've saved time and trouble for many of our customers. We can do the same for you.

SPRINGS
AND FORMED WIRES
WICKWIRE SPENCER STEEL

WICKWIRE SPENCER

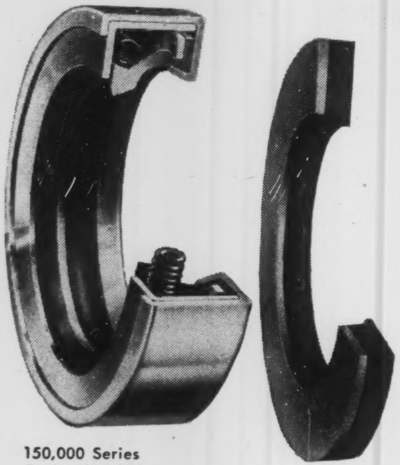
Springs

A PRODUCT OF THE WICKWIRE SPENCER STEEL DIVISION
THE COLORADO FUEL AND IRON CORPORATION
***Spring Sales Office and Plant*—2 New Bond St., Worcester 6, Mass.**
***General Office*—500 Fifth Avenue, New York 18, N. Y.**
***Sales Offices*—Boston • Buffalo • Chicago • Denver. *Pacific Coast*—The California Wire Cloth Corp., Oakland 6, Cal.**

Syntech*

Precision-molded synthetic-rubber for longer, better sealing

HOW TO DESIGN



Oil Seals... Compact National Syntech Oil Seals are supplied for almost any rotating shaft application, in almost any size or style. They are available with single or double-wipe sealing members, tandem or opposed, and can be supplied in spring-loaded or springless-types. Design of sealing lip provides limited shaft contact, for maximum power economy.

NOW...National Syntech seals are proving their superiority on a wide variety of demanding applications

The low coefficient of friction of their precision-molded, synthetic-rubber sealing members gives them unique ability to survive runout, abrasion and high operating temperatures. Syntech seals are unaffected by acids, salines or other deteriorants found in common industrial application. They repeatedly perform at zero leakage over periods greatly exceeding ordinary oil seal life. And they often make possible reductions of sealing friction as high as 70%.

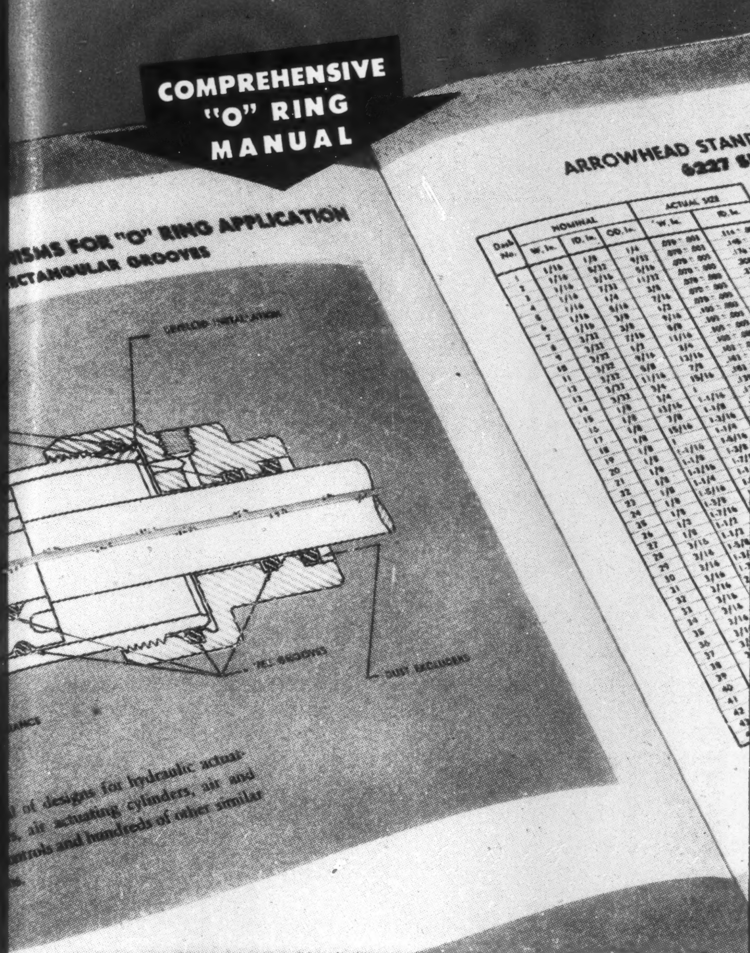
National Syntech Oil Seals are listed by shaft diameter in the new Syntech Catalog. Send for your copy—today.

NATIONAL
OIL AND FLUID SEALS

*TRADEMARK REG.

WHEREVER SHAFTS MOVE, THERE'S A NATIONAL SEAL TO RETAIN THE LUBRICANT

"O" Rings...Available in quantity


COMPREHENSIVE "O" RING MANUAL
ARROWHEAD STANDARD "O" RINGS
6227 SERIES
ISMS FOR "O" RING APPLICATION
CTANGULAR GROOVES
of designs for hydraulic actuat-
air actuating cylinders, air and
ntrols and hundreds of other similar

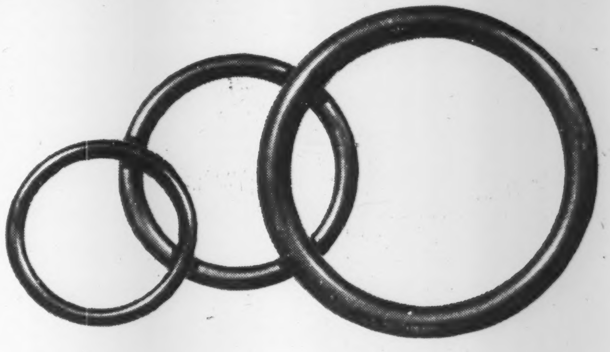
WRITE FOR THIS MANUAL...TODAY

This authoritative "O" Ring Manual offers engineers a comprehensive round-up of current data on installation, use and applicability of "O" Rings. It is fully documented with numerous tables and drawings of great value to designers. Many typical applications... reciprocating and static...are pictured in detail. Cutaway and machine drawings show use of National leather anti-extrusion rings and National Syntech Dust Seals in mechanisms sealed with "O" Rings. "O" Rings, anti-extrusion rings and dust seals are listed by size in easy-to-read tables.

Your copy of this complete "O" Ring book is ready now. Write today. There is no charge or obligation.

NATIONAL MOTOR BEARING COMPANY, INC.

General Offices: Redwood City, California
Plants: Redwood City and Los Angeles, Calif.; Van Wert, Ohio



"O" Rings... These new "O" Rings perform successfully on simple gasket installations where no pressure is involved, or on applications where pressures range as high as 5000 psi. They are used in reciprocating, oscillating, and to a limited extent on rotating mechanisms, as well as static applications. They operate successfully on precision-engineered equipment, and on designs permitting of wide tolerances. They have great natural resiliency, yet possess an inherently low coefficient of friction. They are available in two specifications...commercial and military. The commercial grade is preferable...and more economical...for applications where low temperature extremes are not encountered.

CALL IN A NATIONAL ENGINEER FOR RECOMMENDATIONS

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Room 2014 Field Bldg., Chicago 3
Phone: Central 8663

DETROIT
Room 1026 Fisher Bldg., Detroit 2
Phone: Trinity 16363

MILWAUKEE
1717 E. Kane Place, Milwaukee 2
Phone: Lakeside 2838

SPRINGFIELD
124 State St., Springfield 3, Mass.
Phone: Springfield 2-1881

PHILADELPHIA
401 North Broad St., Philadelphia 8
Phone: Bell-Walnut 2-6997

NEW YORK CITY
122 East 42nd St., New York City 17
Phone: Lexington 2-8260

HOUSTON
1 Main St., Houston 2, Texas
Phone: Preston 9862

KANSAS CITY
1823 Walnut, Kansas City 8, Mo.
Phone: Harrison 6637

CLEVELAND
210 Heights Rockefeller Bldg., Cleveland 18
Phone: Yellowstone 2720

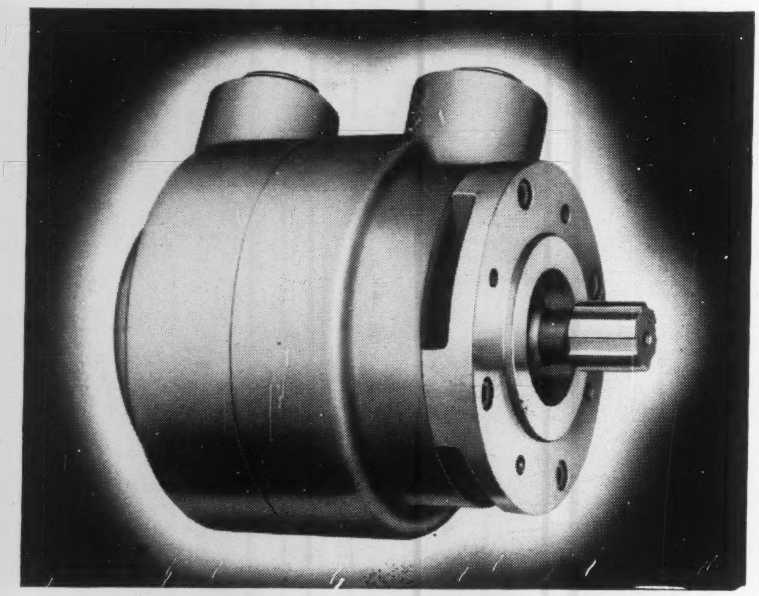
1465

MAKING HISTORY

IN THE FIELD OF HYDRAULICS

DUDCO VANE-TYPE FLUID MOTORS

Space-Saving! Versatile! Low Cost!



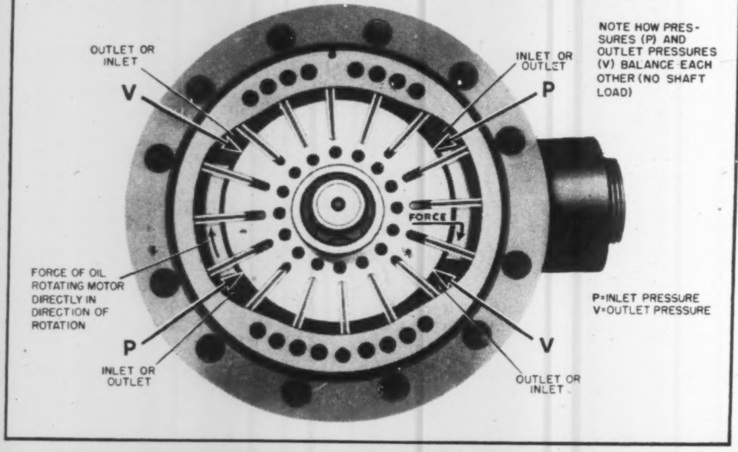
Smaller in size for rating, simpler in design and packed with can't-be-copied features, Dudco Motors are, nevertheless, *lowest in price!* Comparison shows Dudco's price about 30% less than other motors without sacrifice of quality or efficiency:

Our Model M-76,
76 lb.-ins. per 100 psi *only* **$275**
(Price the Same for 250 lb.-ins. model)

Dudco motors are as small or smaller than others of similar capacity, yet sturdy enough for 1500 psi operation—an important space-saving virtue. Slow speed characteristics make possible the *elimination of transmissions,* therefore an additional saving in equipment cost. The higher torque efficiency of Dudco fluid motors makes the combination of small motor *plus* transmission no longer necessary, as the one Dudco motor takes the place of *both,* invariably *costing less than other motors alone!*

Amazing Features and Exclusive Operating Principle That Prove Superiority of Performance In Scores of Applications

Revolutionary New Design—Hydraulically Balanced Vanes


OUTLET OR INLET
V
INLET OR OUTLET
P
NOTE HOW PRESSURES (P) AND OUTLET PRESSURES (V) BALANCE EACH OTHER (NO SHAFT LOAD)
FORCE
FORCE OF OIL ROTATING MOTOR DIRECTLY IN DIRECTION OF ROTATION
P=INLET PRESSURE
V=OUTLET PRESSURE
P
INLET OR OUTLET
V
OUTLET OR INLET

- Stall torque of Dudco Motors is 90% of theoretical at all positions of shaft
- Torques range from 76 lb.-ins. to 250 lb.-ins. per 100 psi
- 3 rpm (smooth) without gear box, with torques to 1000 lb.-ins.
- Size is under 7½" diameter by 8½" long
- Mechanical efficiency (overall) 77% at 100 rpm
- 28 hp at 40 gpm, 1500 psi, 450 rpm
- Maintenance problems can be handled by any good shop mechanic
- Adaptable to applications requiring revolving nut or automatic declutching of shaft from motor
- Hydraulically balanced—no cams or wobble plates to transmit longitudinal motion to radial motion

Get ALL the Facts!

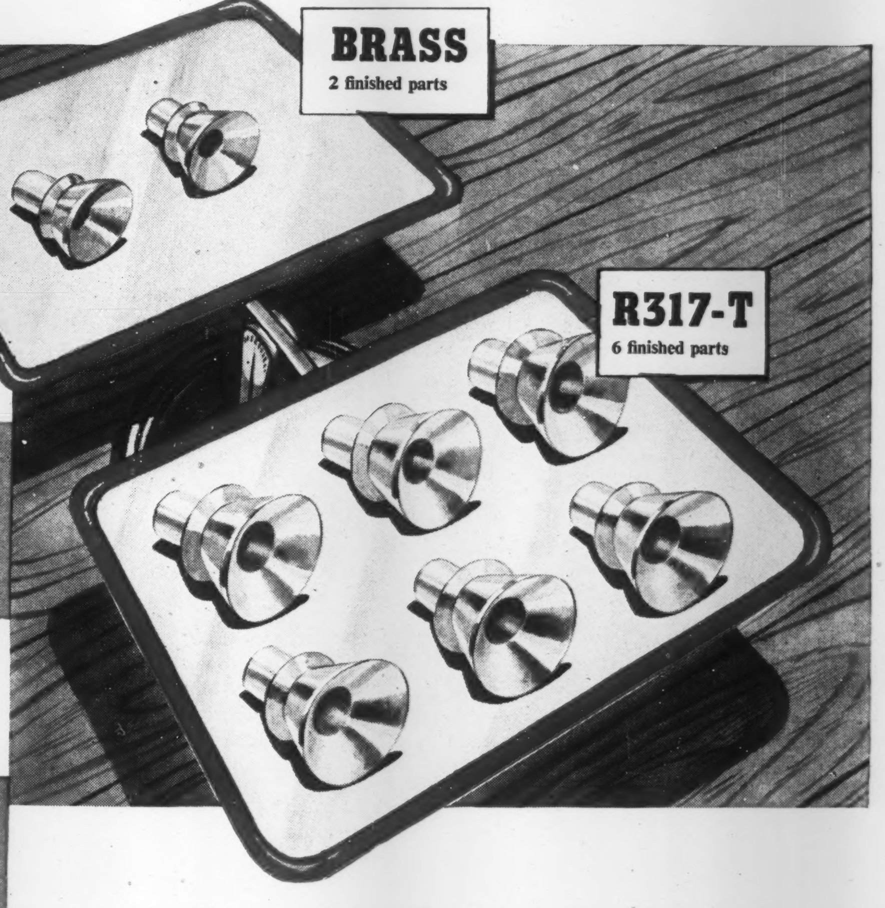
Write at once for descriptive folder and data sheets. Also, we welcome inquiries about specific problems. Our engineering dept. will gladly advise you.

DUDCO
VANE-TYPE
FLUID MOTORS
DUDCO PRODUCTS COMPANY

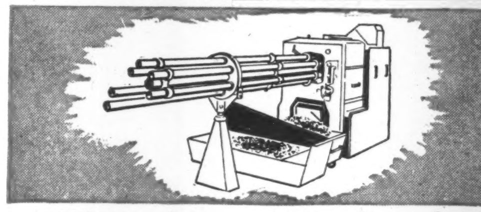
DUDCO PRODUCTS COMPANY
Formerly DETROIT UNIVERSAL DUPLICATOR CO.
18100 RYAN ROAD • DETROIT 12, MICHIGAN

POUND FOR POUND...

...get 3 times as many finished parts!

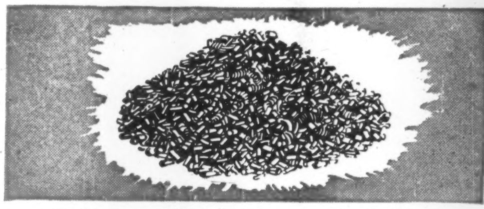


HIGHER SPEEDS



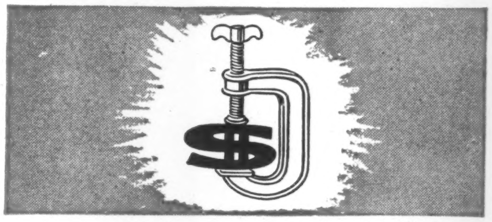
R317-T can be run at high-profit speeds, comparable or in some cases, higher speeds than brass.

CLOSER TOLERANCES



R317-T machines easily to a bright, natural finish. Forms small chips. Does not run with the tool. May be worked to very close limits.

LOWER-COST MACHINING



Accurate volume production with fewer rejects. Result: lower cost, more profit per finished part.

Yes—thanks to the favorable weight factor aluminum gives you three times as many finished parts per pound as brass.

By the foot you pay less for aluminum than you do for brass. All of which adds up to a saving of about 50% in material cost.

For high speeds, excellent machinability, a bright, natural machine finish and LOWER COSTS, use R317-T, Reynolds new aluminum screw machine stock. Only a fraction of the cost per finished piece as R317-T weighs only 1/3 as much as brass (and other heavy non-ferrous metals).

Order now. R317-T is ready for immediate shipment from Louisville warehouse stock in rounds and hexagons in all standard sizes. 17S-T, Reynolds standard screw machine stock, is also available now.

Consult Reynolds. Reynolds is ready to work with your engineers. Offices in principal cities. Phone nearest office . . . or write Reynolds Metals Company, Aluminum Division, 2521 South Third Street, Louisville 1, Kentucky. See Sweet's or write for Catalog 100-B "Reynolds Aluminum—Available now for Today's Products."

REYNOLDS METALS

REYNOLDS
The Great New Source of
ALUMINUM

INGOT · SHEET · SHAPES · WIRE · ROD · BAR · TUBING · PARTS · FORGINGS · CASTINGS · FOIL · POWDER

K-68

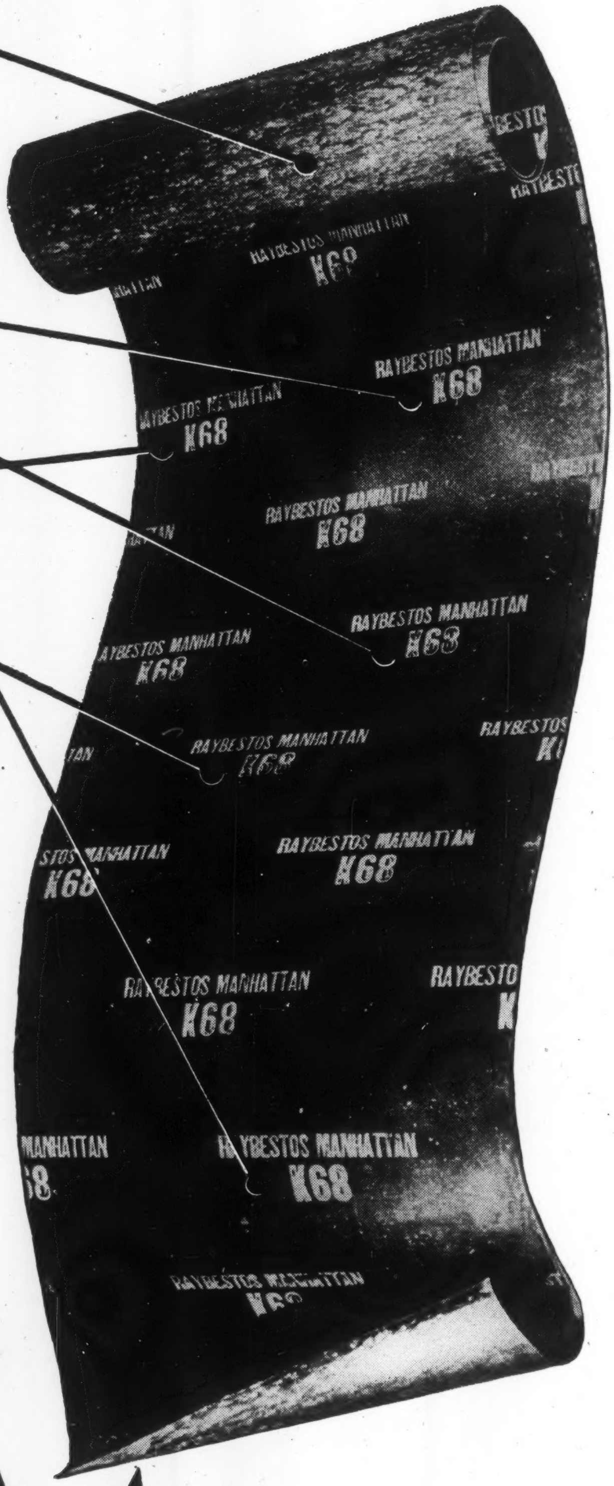
resistance to petroleum oils

high tensile strength

resistance to high temperatures

limited swelling

no sulphur



If you want the very best type of gasket material for gasoline or Diesel engines or for equipment handling light petroleum fractions, specify K-68.

K-68 is a relatively new sheet packing of special synthetic rubber and long-fibre asbestos. It was developed by R/M for use on high output gasoline engines and other applications where oil resistance at high temperatures must be coupled with resilience and strength. It contains no sulphur and is successfully used in refrigeration equipment.

K-68 is now being supplied in large quantities to leading gasket cutters. It meets specification AMS-3232 E and is available in widths up to 60″ and in thicknesses from 1/64″ to 1/8″. Uniformity, aging characteristics, and quality are carefully controlled.

R/M makes a complete line of packings for modern machinery, including packings for high pressures and temperatures; packings for foods, alkalies, acids and other products; plastic and metallic packings; packings of duck, rubber, jute, nylon, flax, blue asbestos and other materials.

Before specifying packings for your machines, let R/M engineers suggest the packing that will contribute to greater operating efficiency and to greater freedom from maintenance problems.

RAYBESTOS
R M
MANHATTAN

R
M

RAYBESTOS-MANHATTAN, INC.

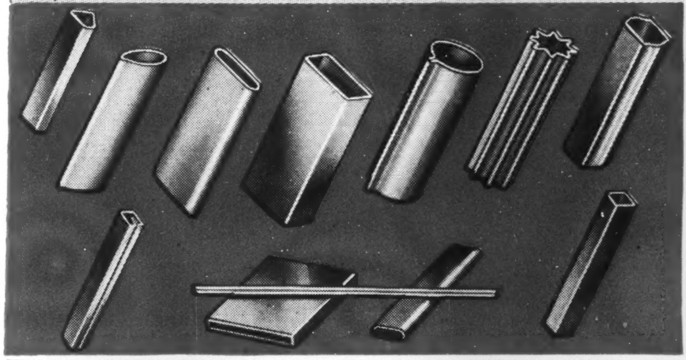
ASBESTOS TEXTILE & PACKING DIVISION

Manheim, Pa. • Bridgeport, Conn. • North Charleston, S. C. • Passaic, N. J.

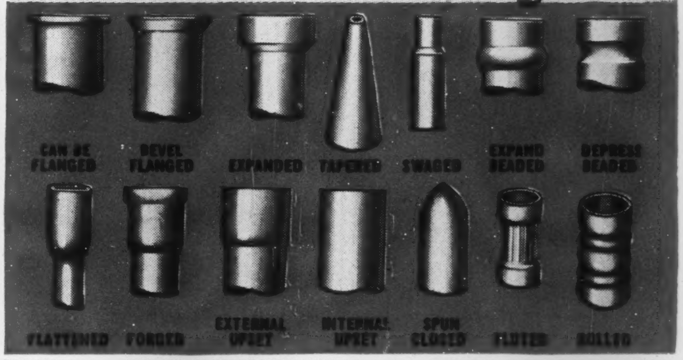
It's "Packed with Satisfaction" When You Use R/M

"STANDARDIZE WITH STANDARD"

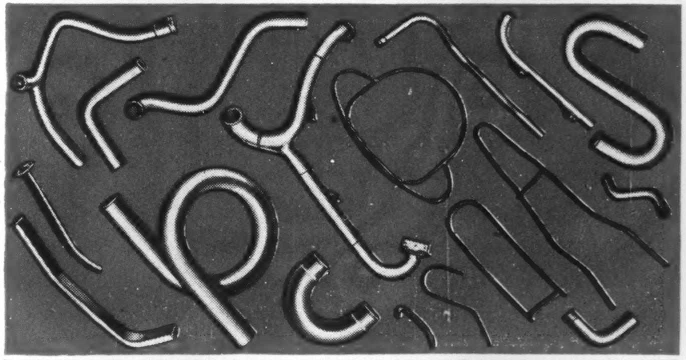
MORE and MORE
"Standard" Shows the Way with More Tubing Uses . . .



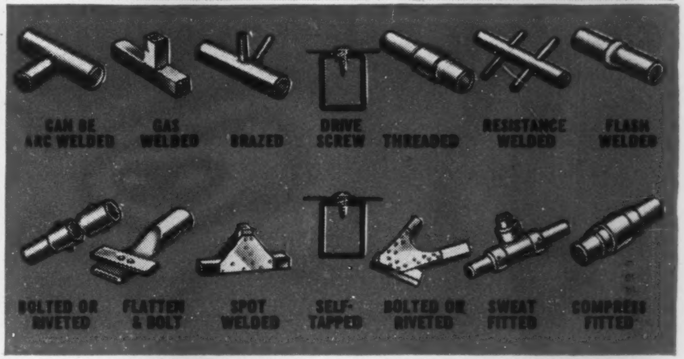
"Standard" Tubing comes in many shapes, sizes, gauges . . .


CAN BE FLANGED
BEVEL FLANGED
EXPANDED
TAPERED
SWAGED
EXPAND BEADED
DEPRESS BEADED
FLATTENED
FORGED
EXTERNAL UPSET
INTERNAL UPSET
SPUN CLOSED
FLUTED
ROLLED

"Standard" Tubing is easy to process in many ways . . .



"Standard" Tubing is easy to bend in any direction . . .


CAN BE ARC WELDED
GAS WELDED
BRAZED
DRIVE SCREW
THREADED
RESISTANCE WELDED
FLASH WELDED
BOLTED OR RIVETED
FLATTEN & BOLT
SPOT WELDED
SELF-TAPPED
BOLTED OR RIVETED
SWEAT FITTED
COMPRESS FITTED

"Standard" Tubing is easy to assemble by many methods . . .

THE STANDARD TUBE CO.
Detroit 3, Michigan
Welded Tubing
Fabricated Parts
STANDARD
STANDARDIZE with "STANDARD" — It Pays

FOR EXAMPLE: Standard Tube Company specialists are showing the way to more and more tubing uses . . . for building interiors, as well as in other specialized fields. Manufacturers of structural and decorative building items, equipment, and furnishings are finding our suggestions profitable. Practical changes or developments frequently result in increased production or improved products by standardizing with "Standard."

Your choice of carbon steels, stainless, and N-A-X., high tensile steel of uniformly high quality . . . with a weld of the same uniform strength and physical characteristics as the tube wall itself. Let "Standard" help you simplify your design, fabrication, and assembly processes!

★ *Complete Tube Stocks Maintained by* ★
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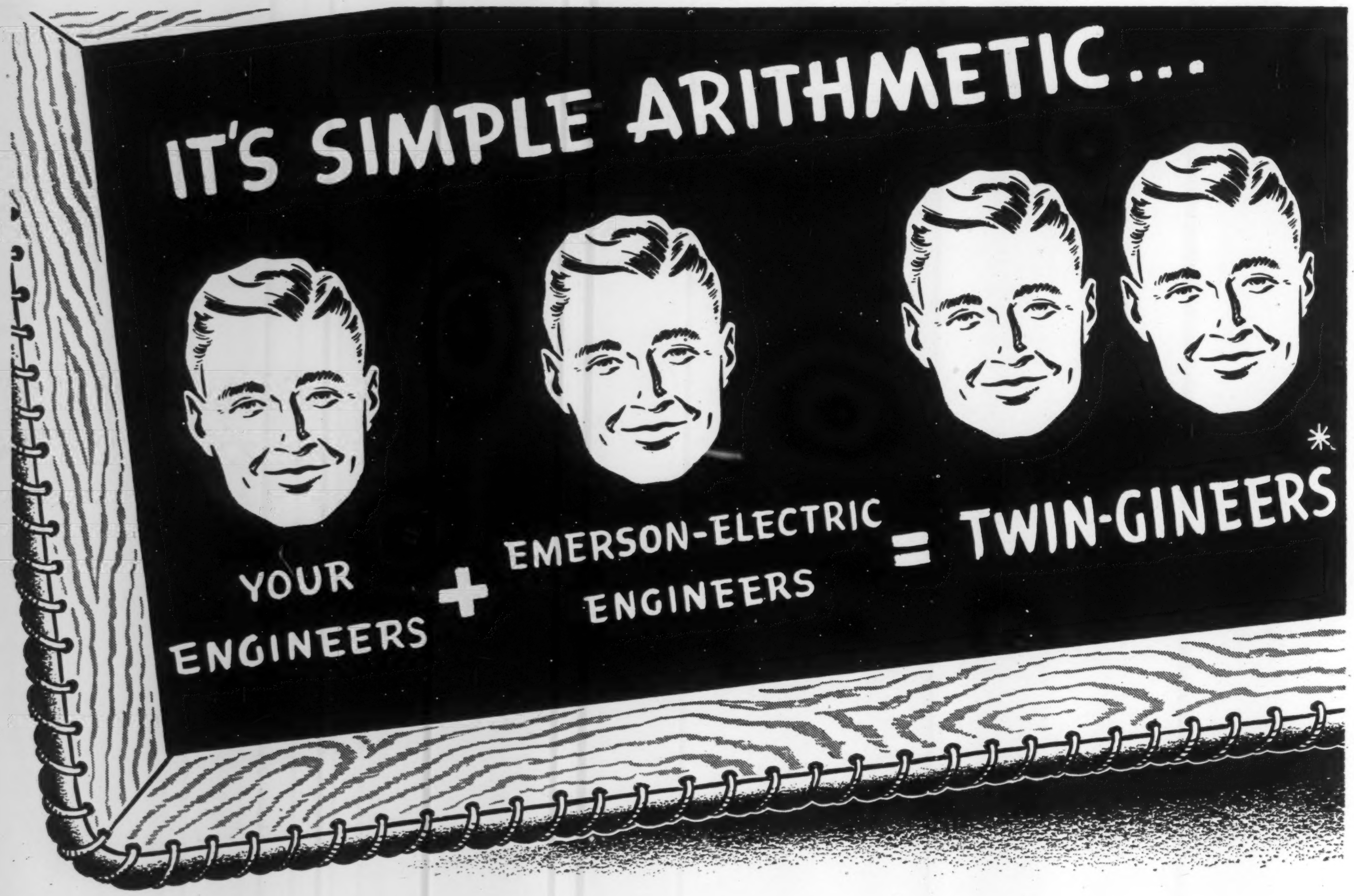
LAPHAM-HICKEY COMPANY, 3333 W. 47th Place, Chicago 32, Ill.
UNION HARDWARE & METAL CO., 411 E. First St., Los Angeles 54, Cal.
THE PACIFIC PIPE COMPANY, 160 Spear St., San Francisco 5, Cal.
METAL GOODS CORPORATION, 1300 Burlington, North Kansas City, Mo.

STANDARDIZE WITH "STANDARD"—IT PAYS!



TWO HEADS* are Better than ONE in designing new Motor-driven Appliances

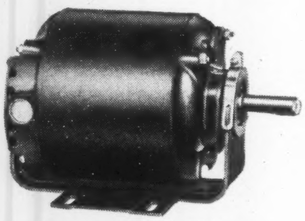
When Emerson-Electric Engineers work with your Design Engineers, to help improve your present motor-driven appliance, or to create an entirely new one, that's *addition!*

When such collaboration eliminates costly engineering back-tracking and results in money-saving short cuts, that's *subtraction!*

And, when your new product wins immediate success because of its many competitive advantages, resulting from co-design, that's *multiplication!*

Anyway you look at it, it's simple arithmetic. Two engineering heads—yours and Emerson-Electric's—are better than one! That's *"Twin-gineering."*

Although Emerson-Electric is presently booked solid on motor orders, our engineers have never been longer on ideas, experience and skill—and never more willing to share these advantages in suggesting more efficient motor applications for your future improved or new equipment. Your inquiry will be welcomed today!



Emerson-Electric Motors
1/20 to 5 H.P.—AC and DC

THE EMERSON ELECTRIC MFG. CO.
St. Louis 21, Mo.

Branches: New York • Chicago • Cincinnati
Detroit • Los Angeles • Davenport

EMERSON ELECTRIC

MOTORS · FANS · APPLIANCES

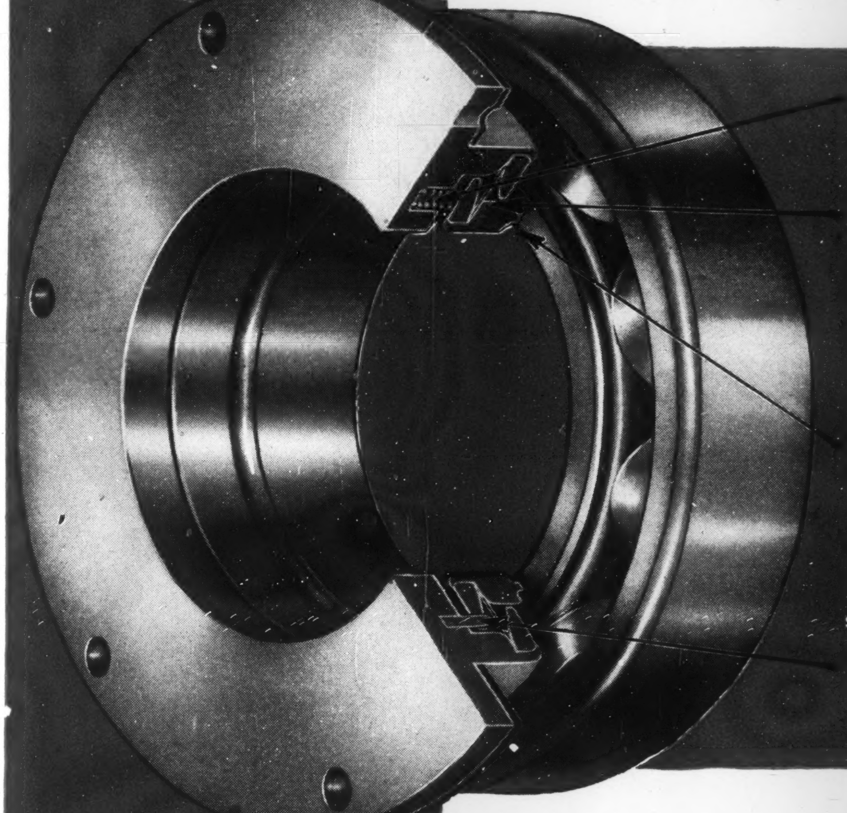
Equal to your most intricate needs

GITS

HIGH SPEED OIL SEALS

—represent over 40 years of specialty engineering

That's Why They Always Satisfy



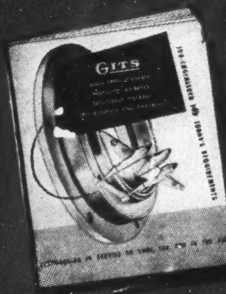
SPRINGS
give proper, evenly distributed pressure on bronze seal ring.

DIAPHRAGM
made of special oilproof and waterproof fabric, resisting heat up to 220° F. constant and 275° F. intermittent. These seals are made also with a metal diaphragm and are used where temperatures are constant above 220° F.

SEALS HERE
Oil is sealed in the bearing chamber by a bronze ring pressing against a bearing race or a hardened and lapped washer. This surface must be lapped free of all scratches and markings.

GUIDE PINS
eliminate torsional strain on diaphragm.

Gits Engineers responsible for the design and function of this world-accepted high speed seal have worked with it and slept with it until they have perfected its development to the finest degree of oil-sealing efficiency possible. In this tried and proved seal, you have a highly-finished and specially-tensioned bronze contact face that operates on a true-running, very hard steel surface lapped to seal oil within a bearing chamber. *This seal does not contact the periphery of the shaft.* Available in ¼" to 4" shaft diameters—larger on application. Permit us to help you on your next sealing problem. Submit complete data for our recommendations.



For detailed information on this and others of the famous Gits line of lubricating devices, write for Bulletin.

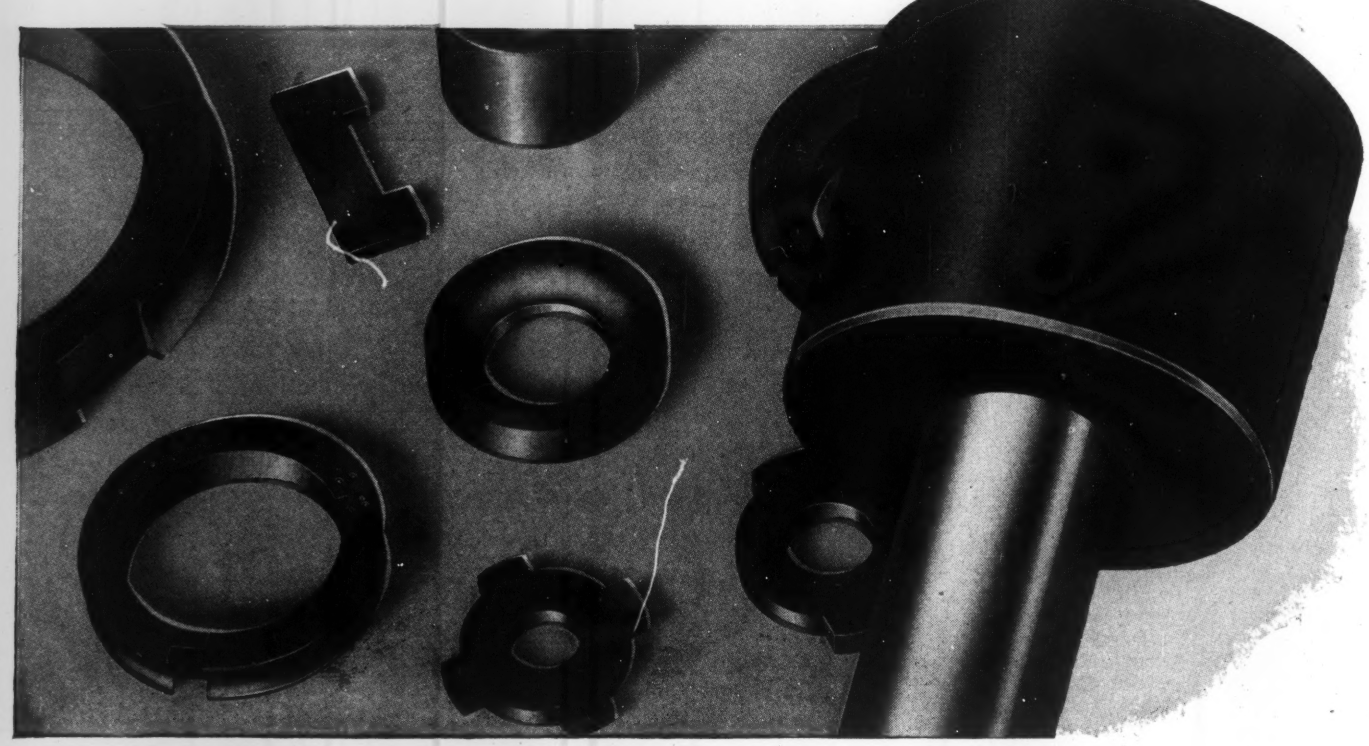
GITS BROS. MFG. CO.
1868 S. Kilbourn Avenue, Chicago 23, Illinois

Exclusive for over 35 Years

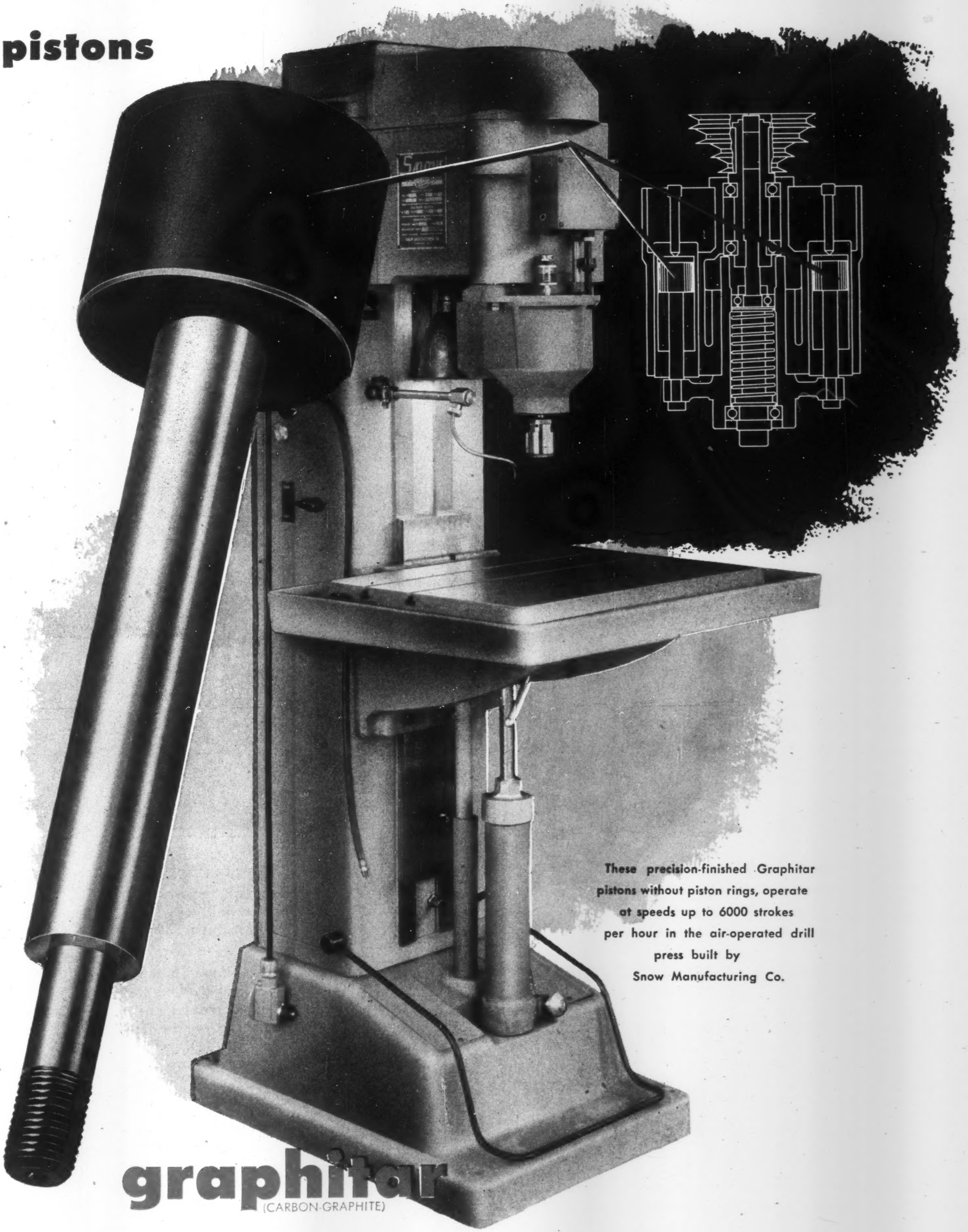
Precision finished graphitar (CARBON-GRAPHITE) operate up to 6,000 strokes per hour in SNOW drill press

GRAPHITAR PISTONS. The smooth, power-packed performance of this air-operated drill press built by the Snow Manufacturing Co. of Chicago depends to a great extent upon the two Graphitar pistons in the cylinder head. Here, as in so many other vital installations in a wide variety of mechanisms, Graphitar proves its efficiency under the severest conditions. These pistons, without piston rings, operate flawlessly, even at speeds up to 6000 strokes per hour. Their precision finish assures instant response to air line pressures which vary from 8 to 100 lbs. per square inch—and that means sure sensitivity of operation. They require minimum lubrication and maintenance because Graphitar is self-lubricating. They are strong and tough—they help prevent costly breakdowns—and they contribute substantially to the reputation for dependability enjoyed by the Snow Air-Operated Precision Drill Press throughout industry.

OTHER GRAPHITAR PARTS. Graphitar seals, bearings, pistons, cylinder liners, and other parts are helping to maintain high efficiency in many types of mechanisms such as compressors, pumps, torque converters, fluid drives, and stuffing boxes. Graphitar is self-lubricating, mechanically strong, chemically inert, extremely light weight, and practically unaffected by temperature extremes. Graphitar parts may be molded and machined to practically any shape with tolerances as close as .0005" in small sizes. Send us sketches or descriptions of your products and we will show you where Graphitar parts will increase mechanical efficiency and save you money.



pistons

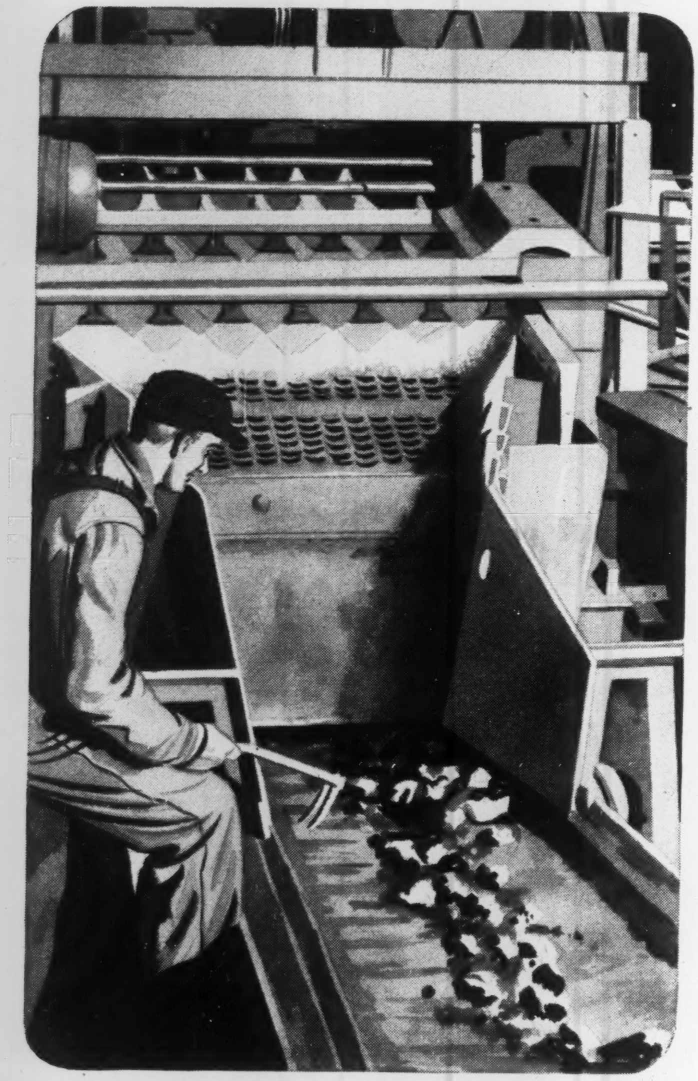


These precision-finished Graphitar pistons without piston rings, operate at speeds up to 6000 strokes per hour in the air-operated drill press built by Snow Manufacturing Co.

graphitar
(CARBON-GRAPHITE)

THE UNITED STATES GRAPHITE COMPANY • SAGINAW, MICHIGAN

Watch industry Fluid-Drive* ahead!



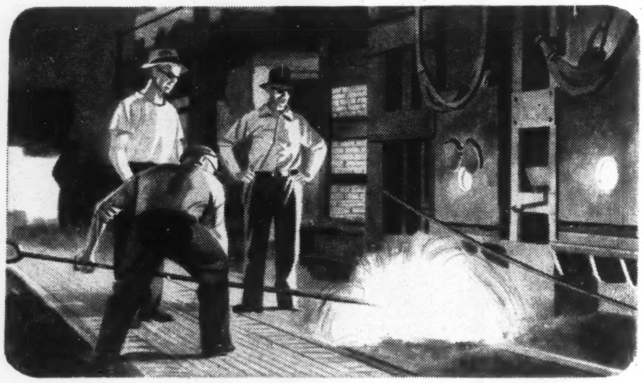
1 Smelting. Follow ore from mine to finished product. Gýrol Fluid Drive has a job at almost every stage. In smelting it protects motors powering conveyors, crushers and rotary kilns. On mechanical draft equipment, Gýrol Fluid Drive is also utilized for adjustable speed control.

AMERICAN BLOWER

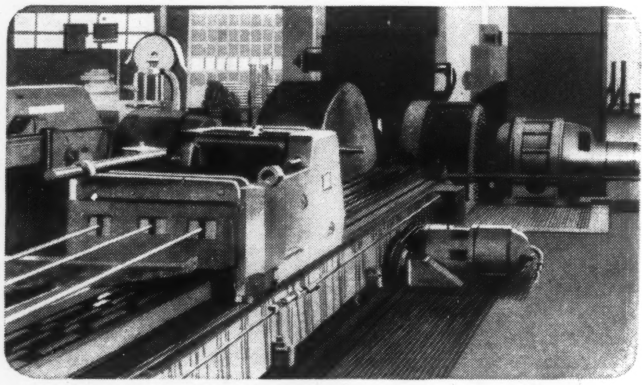
DETROIT 32, MICHIGAN

In Canada: CANADIAN SIROCCO CO., LTD., Windsor, Ont.

Division of AMERICAN RADIATOR & Standard Sanitary CORPORATION



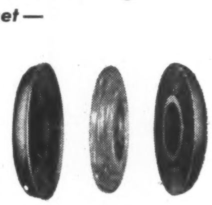
2 Steel. Gýrol Fluid Drive is the answer to a steel mill's needs for protection of such important machines as chargers, conveyors, drawbenches, cranes, as well as other A. C. and D. C. equipment.



3 Metal Working. With Gýrol Fluid Drive, adjustable speed control—from dead stop to full speed—is obtained while using simple, constant speed AC motors. A vortex of oil handles the pull with smooth, even tension. Here's an ideal condition for drawbenches.

4 And You? Industry has found a multitude of uses for Gýrol Fluid Drive. *New applications are being discovered almost daily!* Do they apply to you? Let's investigate the matter together. ***For better performance get—***

GÝROL *Fluid Drive*



* ***Gýrol Fluid Drive*** *is a fluid power transmission pioneered and developed for American industry by American Blower. It is used wherever smooth transmission of power or adjustable speed control is desired. Looking beyond the long list of applications already developed, we will gladly work with you to find new ways to "Fluid-Drive Ahead!"*

JOBS WANTED

FOR THIS WAR VETERAN

POSITION-INDICATING EQUIPMENT

FOR ACCURATE AND RELIABLE INDICATION FROM REMOTE STATIONS

Initially designed for installation in military aircraft, d-c selsyn instruments are proving to be extremely adaptable to a wide variety of industrial uses. Your design men may find that this equipment is the solution to their problems of remote-station indication.

So that we may be of further service to design engineers, we have just completed an application manual to assist in the selection and use of position-indicating equipment. The three-wire, three-coil system is presented in this manual to the exclusion of the numerous other d-c selsyn systems that have been devised and are available for special purposes. It is the most versatile system and, therefore, the most widely used for general position-indicating applications.

Let our engineers help you with any unusual applications that require special consideration; and for your own free copy of our d-c selsyn position-indicating equipment manual, GET-1304, call your nearest G-E sales office or write to Apparatus Dept., Section D607-12, General Electric Company, Schenectady 5, N. Y.

GENERAL ELECTRIC
607-12

YOUR DESIGN ENGINEER WILL BE INTERESTED IN THESE SELSYN FEATURES

Simplicity of design and of construction

Freedom from temperature, position, and voltage errors

Light weight

Operation from 24-volt power supply

Compactness

Low power consumption

Interchangeable elements

Parallel operation

Low maintenance costs

No hairsprings used

No lubrication required

Radio and magnetic shielding

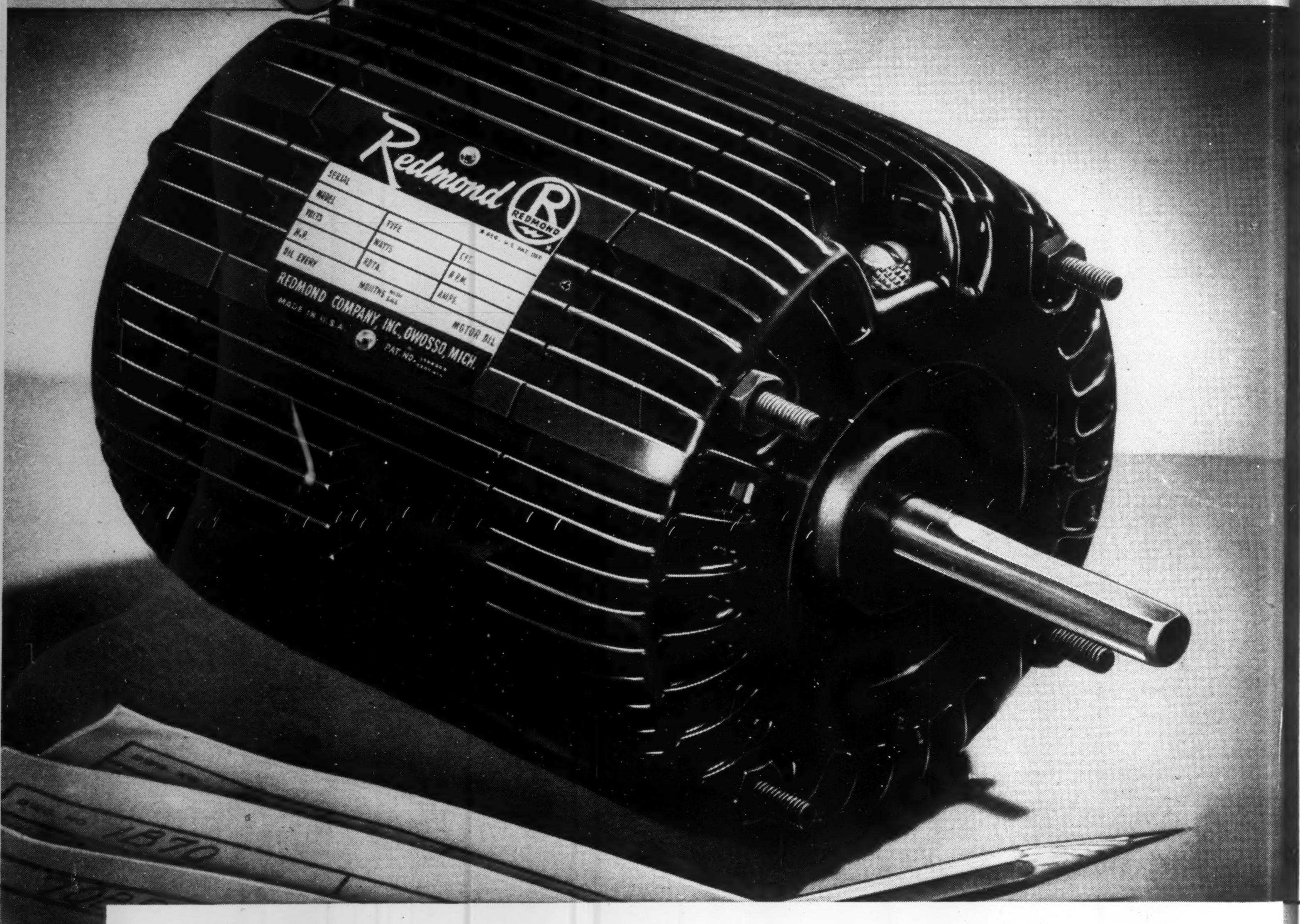
Long life

Power-failure indication

Variety of designs

NEW 1/20th HORSEPOWER

Redmond


Redmond
SERIAL
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VOLTS
TYPE
H.P.
WATTS
CYC.
OIL EVERY
ROTA.
R.P.M.
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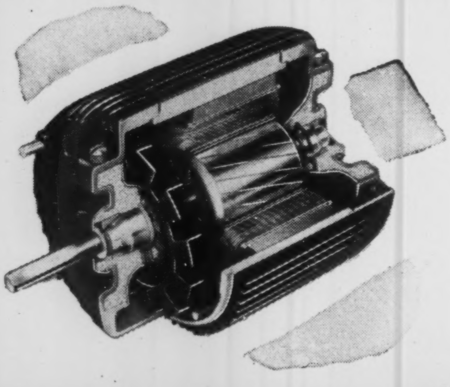
AMPS.
REDMOND COMPANY, INC., OWOSSO, MICH.
MOTOR OIL
MADE IN U.S.A.
PAT. NO.
REDMOND
1370



You Get **ALL THESE FEATURES** In The Type "U"

- ★ Full 1/20 HP. at 1500 R. P. M.
- ★ Totally enclosed 4-pole shaded pole
- ★ 2 sq. inches bearing surfaces
- ★ Bearings spaced 5 inches overall
- ★ Individually fitted bearings
- ★ 6 cu. inches in oil reservoirs
- ★ Super-Life circulating lubrication
- ★ Operates in any position
- ★ Lubricated silent thrust washers
- ★ Flush-Weld precision skewed rotor
- ★ Humidity and oil resistant windings
- ★ Controlled end play
- ★ Sturdy die cast machined frame
- ★ Fin-Line functional styling
- ★ 198 sq. inches cooling surface
- ★ Internal air circulation

LONG-LIFE MICROMOTOR –

TYPE "U"

For A.C.
Operation

STRIKE UP an acquaintance with the neatest number that's come along in many a year.

Especially if you're hankering for twentieth horsepower jobs, you'll want every last detail on the new Redmond Type "U" long-life Micromotor.

The basic design for this new Type "U" was determined by thoroughly checking requirements of the motor-consuming markets. As a result, the Type "U" embodies these desirable key features:

Shaded pole design, for speed control and utmost reliability.

Generous broadly spaced bearings, for maximum smoothness.

Super-Life lubrication, to permit continuous operation for unlimited periods, with Micromotor mounted in any position.

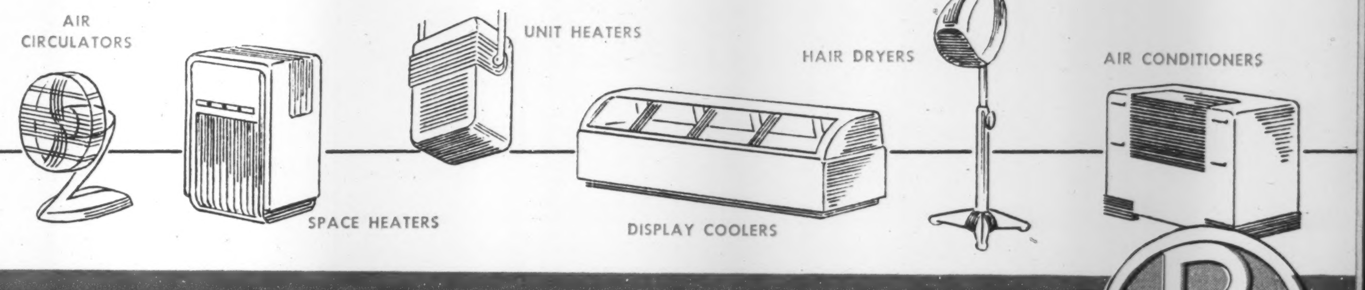
Sturdy die cast construction, in modern functional styling.

The Redmond engineers went the whole way. You'll find the Type "U" loaded with remarkable engineering accomplishments.

It's the culmination of years of designing, testing and mass production experience. It's built by the same specialists who have already turned out more than 20,000,000 dependable Redmond Micromotors. It's the kind of motor you'll want.

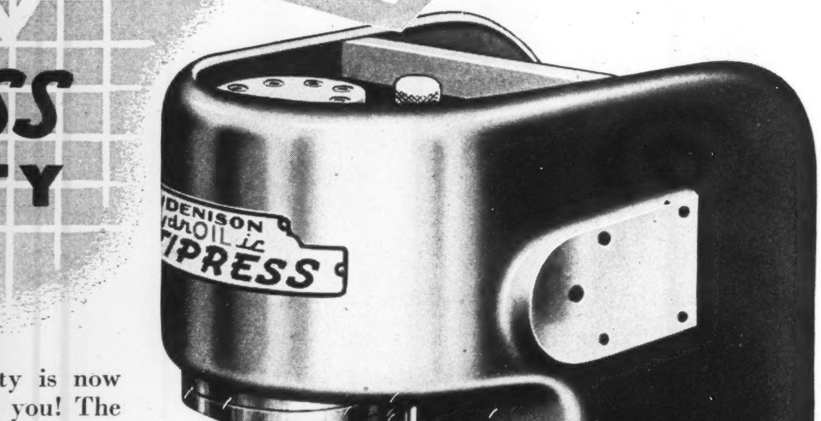
Phone or drop us a line today. Ask about the Redmond Type "U" Micromotor.

Illustrated below are just a few of the many applications for which Type "U" Micromotors are ideally suited:



Redmond
COMPANY, INC.
MAIN OFFICES, OWOSSO, MICHIGAN, U. S. A.

Composite view of Redmond plants



Now Available at No Extra Cost!

DENISON'S UNIQUE

Multi-Speed Control

FOR ADDED *MULTIPRESS* VERSATILITY

GREATLY increased Multipress adaptability is now yours—without one penny of extra cost to you! The new Multi-Speed control feature is now a standard part of all basic Multipress units, adding new versatility once available only on higher priced models. All the production-boosting features of the Multipress are still present, with many added improvements.

Ram stroke, pressure and speed are under constant control of the operator. Pressure can be increased or decreased while the ram is on the work. Ram speed can be varied at any point in the downward travel of the ram to the work. This advantage permits the ram to approach the work at high speed while its pressing speed can be regulated. Adjustable features permit close limitation of upward and downward ram travel.

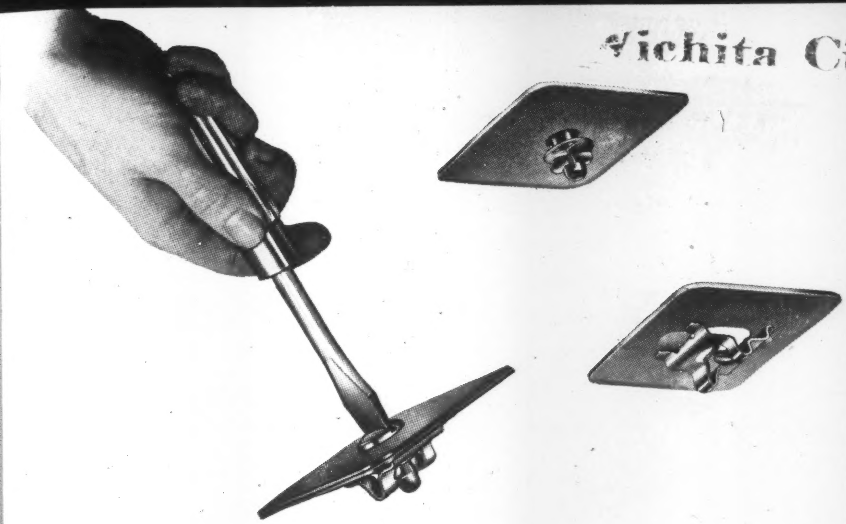
Denison now has a colorful 28-page booklet "Multipress, And How You Can Use It." You'll find its pages packed with helpful information about Multipress and how it has solved production problems in almost every industry—plus complete information on the Multi-Speed control. Write for your copy today, and learn why Multipress is the proven answer to hundreds of needs for increased production.

THE DENISON ENGINEERING COMPANY
1156 Dublin Rd., Columbus 16, Ohio

HydrOILics
INDUSTRY'S RIGHT HAND

DENISON
EQUIPMENT *in* APPLIED
HydrOILics

Wichita Cit



FASTER OPERATION
FOR
ACCESS PANELS

¼ TURN OPENS OR LOCKS
SHAKEPROOF
Q-FASTENERS

Shakeproof Q-Fasteners have been developed around the cam locking principle to combine secure locking of cover plates and panels with the easiest possible access to the housed units. These special fasteners eliminate the possibility of accidental opening or loosening . . . eliminate rattles and provide a clean smooth appearance since only the stud head is visible on the exposed surface.

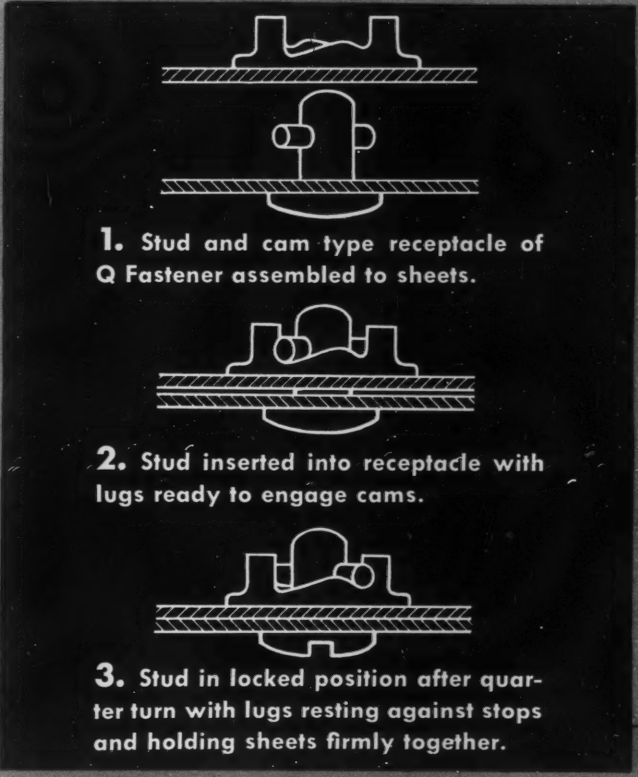
Q-1 Fasteners, illustrated at right, are designed for use where extreme loads are encountered. Their design provides a powerful lock which when assembled also has great structural strength. Installation is easy as there are only 3 parts—stud, cross pin and spring receptacle.

Q-2 Fasteners are similar in action to the Q-1 but the design has been simplified to speed up assembly and reduce costs. Where loads are not extreme the Q-2 provides fast locking and unlocking with long dependable performance assured.

Add the convenience of fast operation to the panels, doors and covers of your product. Write for Shakeproof Engineering Data Bulletin No. S-75 today!

SHAKEPROOF inc.
"Fastening Headquarters"

Division of ILLINOIS TOOL WORKS
2501 North Keeler Avenue, Chicago 39, Illinois
Offices in Principal Cities
Plants at Chicago and Elgin, Illinois • In Canada:
Canada Illinois Tool, Ltd., Toronto, Ontario

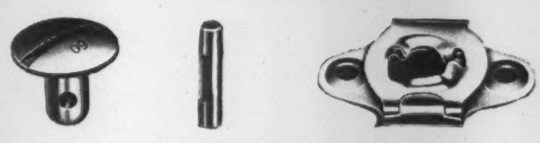


1. Stud and cam type receptacle of Q Fastener assembled to sheets.

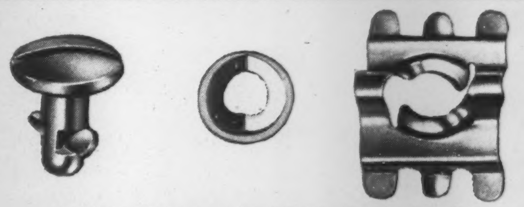
2. Stud inserted into receptacle with lugs ready to engage cams.

3. Stud in locked position after quarter turn with lugs resting against stops and holding sheets firmly together.

TWO STANDARD TYPES

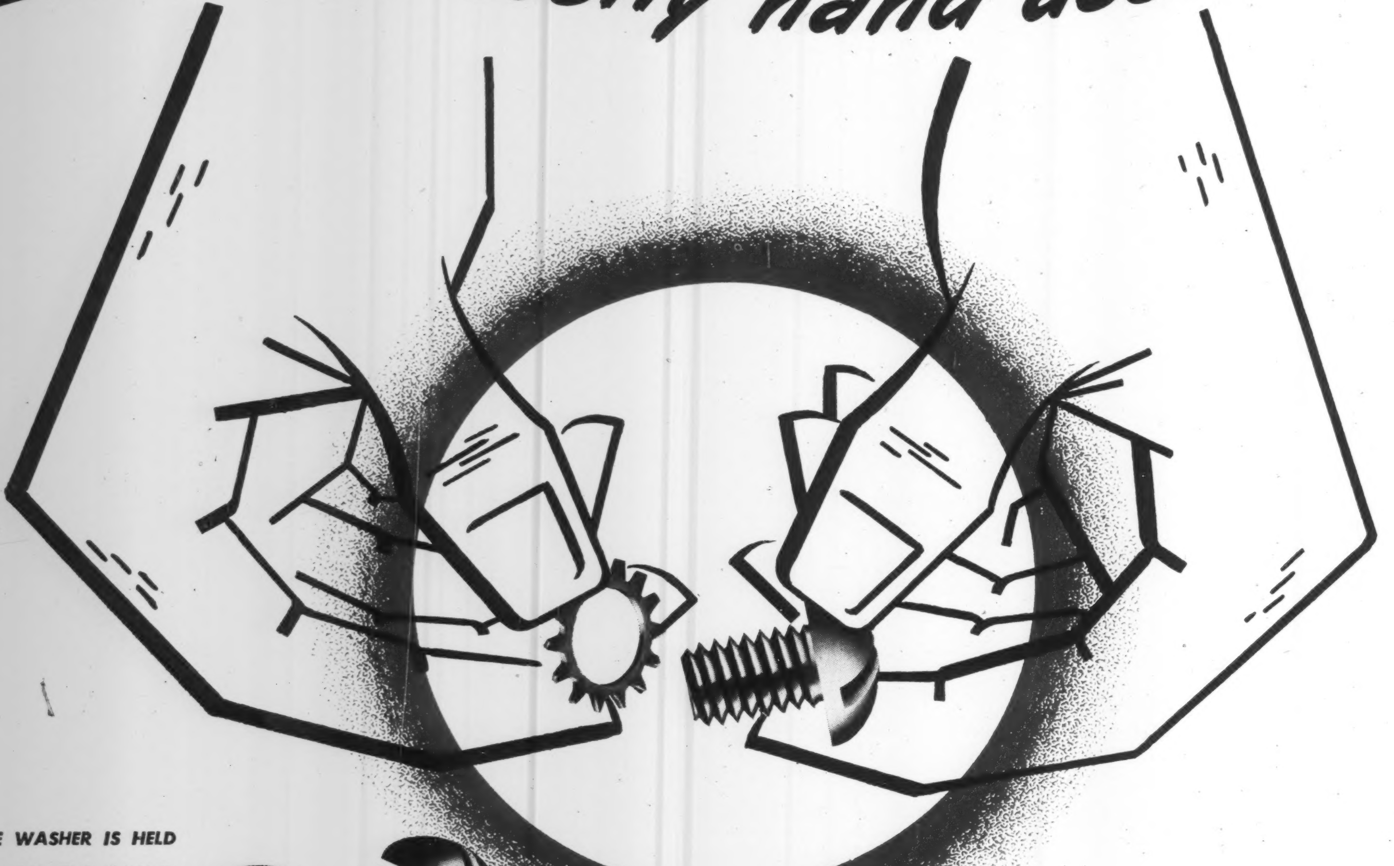


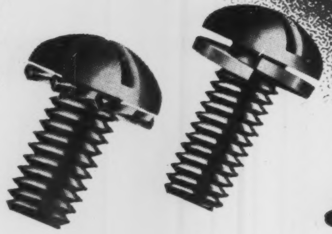
SHAKEPROOF Q-ONE



SHAKEPROOF Q-TWO

Eliminate costly hand assembly



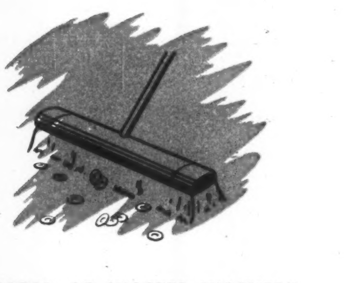


THE WASHER IS HELD ON BY THE ROLLED THREAD AND IS FREE TO ROTATE!

save money with SEMS

TWO PARTS PRE-ASSEMBLED; ONLY ONE UNIT TO ORDER, STOCK AND HANDLE.

DRIVING IS EASIER, FASTER. SEMS ARE PERFECT FOR HARD TO REACH PLACES.



NO DROPPED OR WASTED WASHERS. ASSEMBLY MOVES SMOOTHLY.

ANY OF THESE MANUFACTURERS WILL SEND YOU THE SEMS DATA BOOK, *FREE!*

Eaton Manufacturing Co.
Reliance Division
Massillon, Ohio

The Lamson & Sessions Co.
Cleveland, Ohio

National Lock Co.
Rockford, Illinois

The National Screw & Mfg. Co.
Cleveland, Ohio

New England Screw Co.
Keene, N. H.
Pheoll Manufacturing Co.
Chicago, Illinois
Russell, Burdsall & Ward
Bolt & Nut Co.
Port Chester, N. Y.
Scovill Manufacturing Co.
Waterville Division
Waterville, Conn.

Shakeproof Inc.
Division of Illinois Tool Works
Chicago, Illinois
Steel Co. of Canada, Ltd.
Hamilton, Ont., Can.
Stronghold
Screw Products Inc.
Chicago, Ill.
American Screw Co.
Providence, R. I.

Central Screw Co.
Chicago, Ill.

Chandler Products Corp.
Cleveland, Ohio

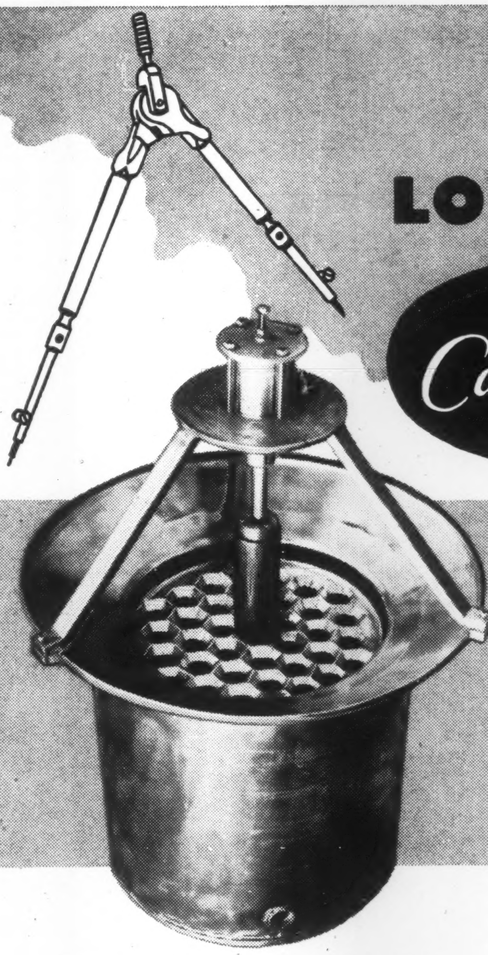
Continental Screw Co.
New Bedford, Mass.

Corbin Screw Division
The American Hardware Corp.
New Britain, Conn.

ILLINOIS TOOL WORKS • CHICAGO • Licensor of machines and methods for the manufacture of sems

Design for LOWER UNIT COSTS

with *Carpenter* STAINLESS TUBING...

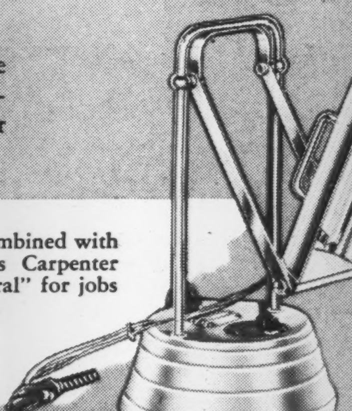


Paraffin melter using Carpenter Stainless Tubing (Type 304), 1⅛" O. D. x 16 gauge, hexagon on ends and welded together to eliminate flat spots which might interrupt flow of paraffin.

You can quickly find new ways to lower unit costs—and improve your product's performance—with Carpenter Stainless Tubing. Because of its ***uniform walls,*** this tubing gives you:

- Easier fabrication—bending, flanging, flaring, expanding, rolling-in for tube sheets.
- Weight savings—because you don't have to specify a heavy gauge to make up for possible "thin spots" in the tube wall.
- Lower material costs—result from specifying lighter gauges.
- New sales advantages—because of the more uniform corrosion and heat resistance properties provided by tube walls that are always uniform.

To get the most from every foot of Stainless Tubing you use, make use of Carpenter's 20 years of experience with corrosion and heat control, engineering and fabricating problems. Our experience is yours for the asking, so tell us about your problem.



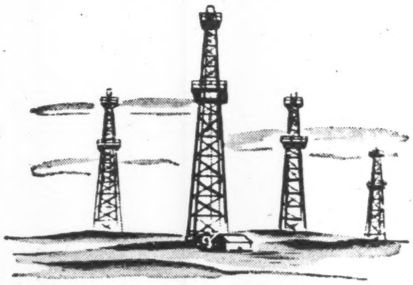
Gleaming sales appeal combined with rugged durability makes Carpenter Stainless Tubing a "natural" for jobs like this sun lamp stand.

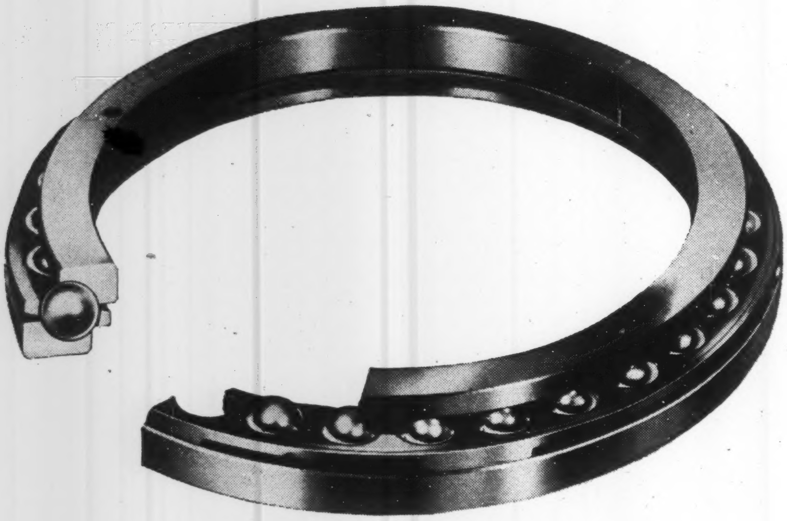
CARPENTER STAINLESS TUBING for

—Strength and Rigidity
—Weight Savings
—Corrosion Resistance
—Heat Resistance
—Accuracy
—Fabricating Savings
—Longer Service Life
—Sales Appeal

THE CARPENTER STEEL COMPANY • *Welded Alloy Tube Division • Kenilworth, New Jersey*

Carpenter STAINLESS TUBING





For unusual and large size bearings . . .

like the large, 48" OD angular contact ball bearing illustrated, or for other heavy duty, large size, or out-of-the-ordinary anti-friction bearing requirements,

Our specialized experience can help you.

Designing and building special anti-friction bearings such as ball-reciprocating, ladder type and radial roller bearings, as well as all major types of standard large size bearings, have long been a major activity of Torrington's Bantam Bearings Division. This background of experience is available to assist you in similar or entirely new problems involving the application of anti-friction engineering principles.

THE TORRINGTON COMPANY

SOUTH BEND 21, INDIANA
TORRINGTON, CONN.

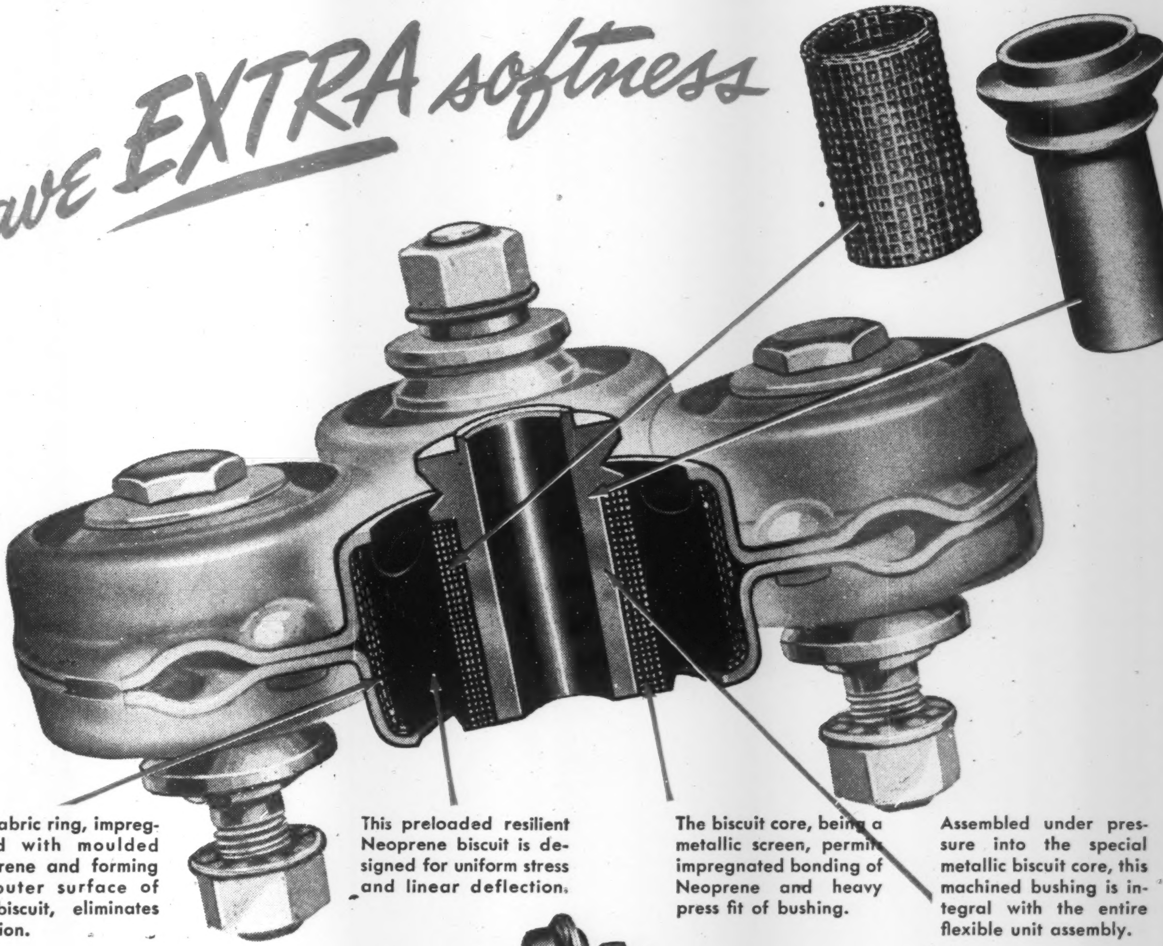
Offices in All Principal Cities

TORRINGTON BEARINGS

• NEEDLE • SPHERICAL ROLLER • STRAIGHT ROLLER • TAPERED ROLLER • BALL •

Here are the FACTS on why MORFLEX COUPLINGS

have EXTRA softness

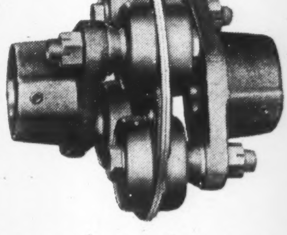


This fabric ring, impregnated with moulded Neoprene and forming the outer surface of the biscuit, eliminates abrasion.

This preloaded resilient Neoprene biscuit is designed for uniform stress and linear deflection.

The biscuit core, being a metallic screen, permits impregnated bonding of Neoprene and heavy press fit of bushing.

Assembled under pressure into the special metallic biscuit core, this machined bushing is integral with the entire flexible unit assembly.



Supplied in eleven sizes, Morflex couplings provide an unrivalled range of torsional flexibility from 1.9 to 200 lbs. ft. per degree, with torque capacities varying from 3 to 725 lbs. ft.

This torsionally "soft" coupling uses the exclusive Morse-designed preloaded Neoprene biscuit assembly whose live, muscle-like flexing takes the wrap-up of torsional loads, protects your machine installations from shock, vibration and uneven impulses. Misalignment stresses are minimized and bearing life increased.

A positive, direct drive with no power loss, the Morflex coupling is engineered for tough, dependable service. Its construction eliminates metal-to-metal contact between driving and driven members, requires no lubrication, is sealed against dirt, dust and weather. It will give long life and trouble-free operation to your installation. Consultation with Morse engineers is available without charge—address Coupling Division, Detroit.

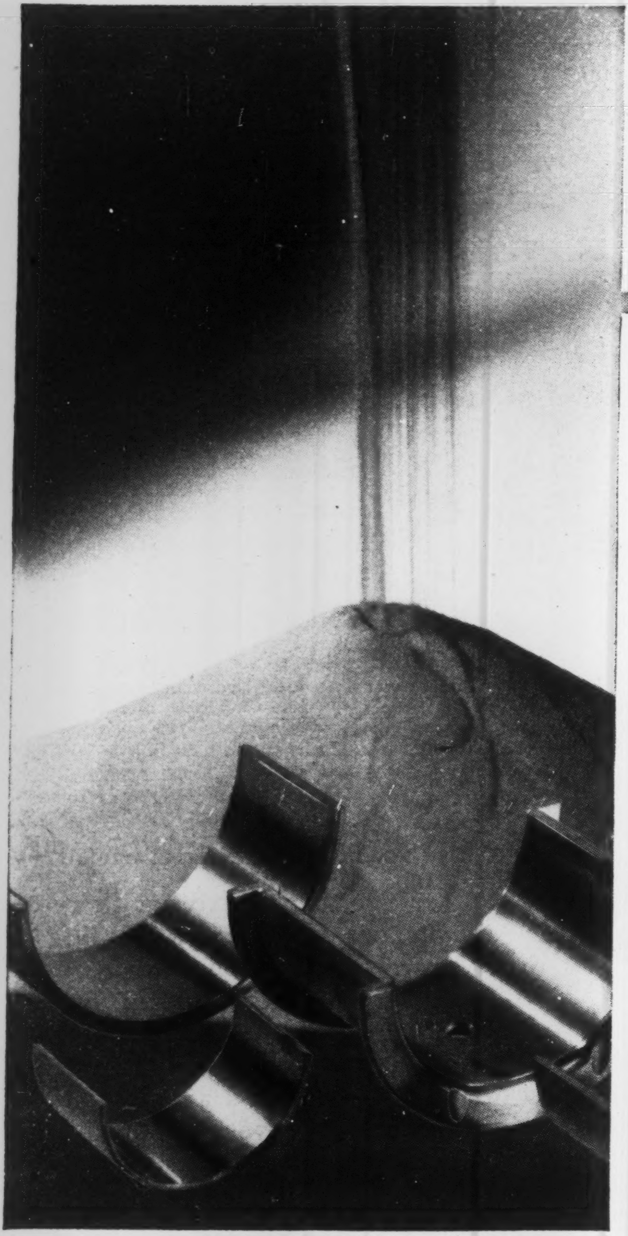
MORSE CHAIN COMPANY • Detroit 8, Michigan • Ithaca, New York

MORSE MECHANICAL POWER TRANSMISSION PRODUCTS

A PRODUCT OF B-W BORG-WARNER

SINTERED COPPER LEAD BEARINGS

Further Improvements in Copper Lead Alloy Powders result in Longer Bearing Life



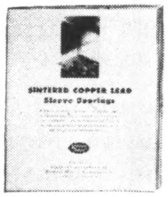
Much higher performance standards can be expected with our *improved* copper lead alloy lining materials. The new alloys have exceptional purity, known and controllable grain structure, and have ductility and strength exceeding those of cast copper lead alloys of comparable analyses.

The powder permits excellent lead distribution. Lead segregation, so common in cast types, is avoided. For this reason alloys with as high as 45% lead content are readily produced.

Overplating is generally used with the harder, lower lead content powders, such as our H-24 (24% lead). Cost of overplating is avoided with higher lead content powders, which also eliminate the need for hard crankshafts. The higher the lead content of the bearing, the softer the shaft can be.

• • •

A new technical bulletin has been published describing the development of this improved alloy. A copy will be sent free on request.

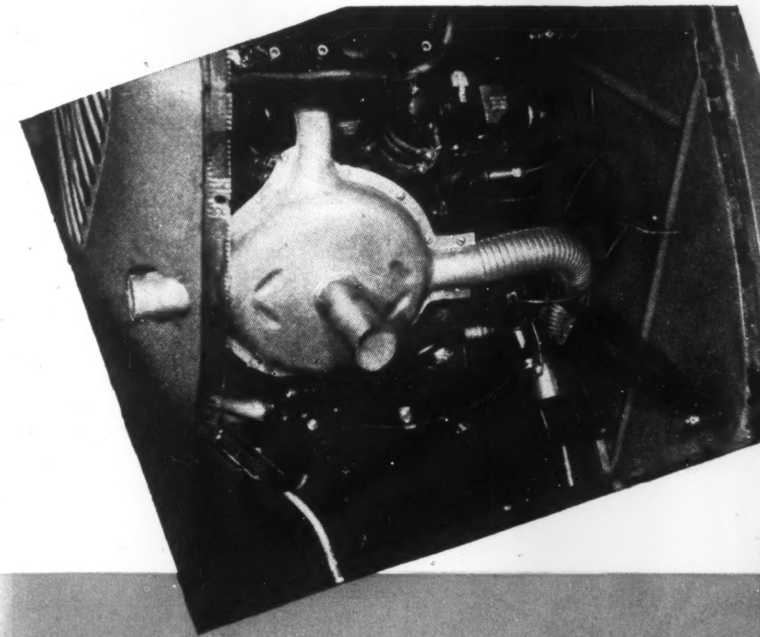


FEDERAL-MOGUL CORPORATION
11045 Shoemaker • Detroit 13, Michigan

Power goes to work through

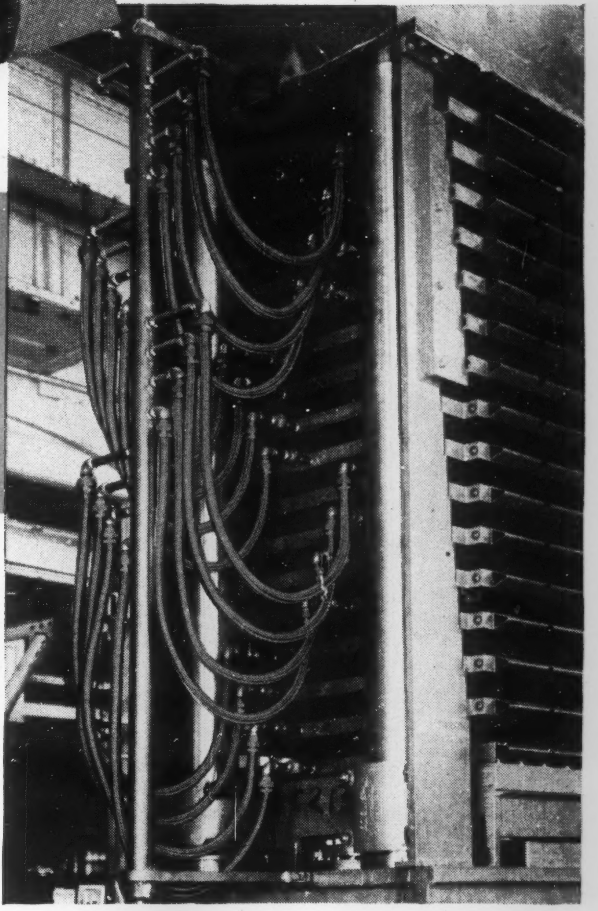
FEDERAL-MOGUL *Silent* SLEEVE BEARINGS

FEDERAL Mogul



In the new Ryan lightplane muffler, American Flexible Metal Hose conducts cold air from the air stream to the heat exchanger and warm air from the heat exchanger to the cabin heater. This hose is 2" O.D. Type UI aluminum.

Whether you put heat in, or take it out . . .



In this press that bonds plywood panels, 15 at a time, hot water is brought to the movable 100" x 50" hot plates through American Seamless Flexible Metal Tubing, reinforced with bronze braid and attached with brass couplings. Press manufactured by Williams, White & Co., Moline, Ill.

Flexible METAL HOSE

Performs Best

What's *your* problem in flexible connections? Whether it involves vibration, misalignment or connecting moving parts while conveying steam, oil, water, other liquids, semi-solids or gases, you'll find a solution in the complete line of American Flexible Metal Hose and Seamless Tubing.

American Seamless Flexible Metal Tubing, as flexible as garden hose, and as leakproof as the seamless bronze tube from which it is made, is standard in sizes ⅛" to 4" I.D. *American Metal Hose* is available in brass, bronze, aluminum, steel and other metals, some of these in sizes up to 12" I.D.—made from strip in four spirally wound types. Either hose or tubing can be furnished complete with fittings to your exact specifications.

Detailed information is available on request, and our Technical Department will gladly cooperate on any unusual problems.

47293

ANACONDA
from mine to consumer

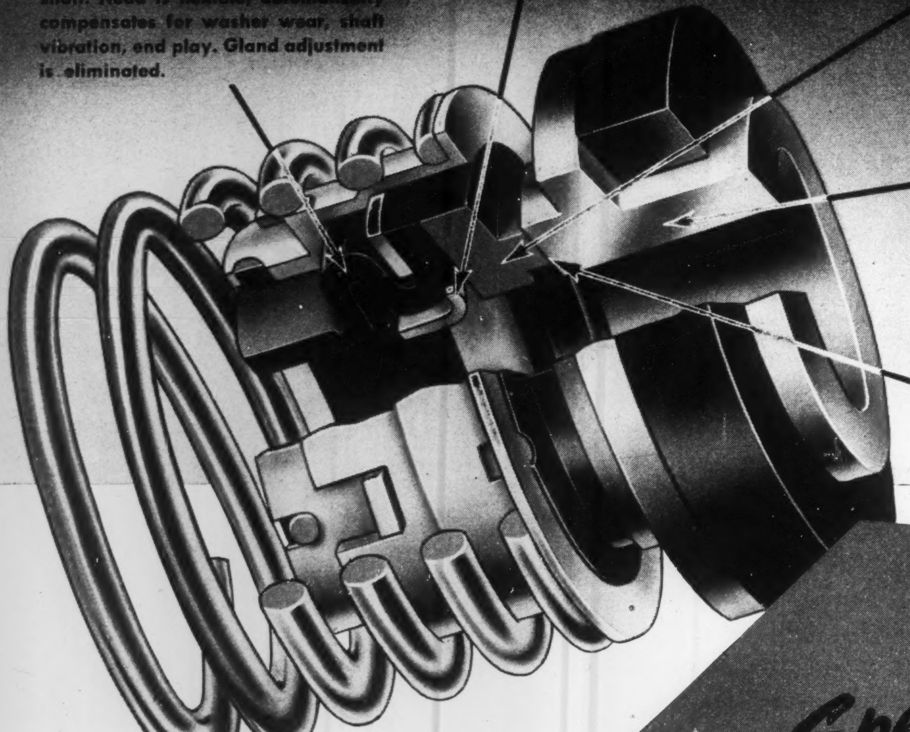
American
METAL HOSE
THE AMERICAN BRASS COMPANY
American Metal Hose Branch
General Offices: Waterbury 88, Connecticut
Subsidiary of Anaconda Copper Mining Company
In Canada: THE CANADIAN FAIRBANKS-MORSE CO., LTD., *Montreal 3, Canada*

Eliminate Leakage, Gland Adjustment and Shaft Wear from Rotary Equipment

Synthetic Rubber Bellows—tail seals on shaft. Head is flexible; automatically compensates for washer wear, shaft vibration, end play. Gland adjustment is eliminated.

[illegible] movement of bellows at all times.

Sealing Washer—[illegible] is driven through metal parts. [illegible] on bellows. Washer made of anti-frictional material—cuts power loss to a minimum.



Floating Seat—cushioned by synthetic rubber sealing ring, eliminating stress distortion of sealing faces.

Sealing Faces—both carefully lapped to insure a perfect seal. Sliding seal contact is made at this point only; there is absolutely no wear of the shaft.

The JOHN CRANE Shaft Seal is being applied with tremendous success to all types of equipment involving rotating shafts. Service and product-improvement records have been outstanding, for this self-adjusting seal practically eliminates the human element in maintenance.

Investigate the JOHN CRANE Shaft Seal. Let our Engineers show you without obligation how this seal can add new sales features to your products.

Write today for illustrated Shaft Seal Bulletin.

Specify
JOHN CRANE SHAFT SEALS

CRANE PACKING COMPANY

BALTIMORE, BOSTON, BUFFALO, CLEVELAND, DALLAS, DETROIT, HOUSTON, LOS ANGELES, NEW ORLEANS, NEW YORK, PHILADELPHIA, PITTSBURGH, SAN FRANCISCO, ST. LOUIS, TULSA

1825 CUYLER AVE. • CHICAGO 13, ILL.

CRANE PACKING CO., LTD., Hamilton, Ontario, Canada.
Branches: Montreal, Toronto, Vancouver

WHEN YOU SEE IT STOPPED YOU *KNOW* IT IS STOPPED

Norgren
DENVER

GET THAT AIRLINE MOISTURE BEFORE IT GETS YOUR TOOLS AND CYLINDERS

Corrosive, rust-creating moisture and compressor emulsions that raise merry Hades with fine tools have been getting past conventional air filters.

BUT MOISTURE IS NOW "STOPPED COLD" BY THE NEW NORGREN TRANSPARENT BOWL FILTER — with exclusive "Tornado Jet" and "Quiet Zone" features. *You can actually see the moisture being separated!*

- Directional air inlet (Tornado Jet) imparts swirling motion, separating and throwing moisture against outer wall.
- Moisture runs down below baffle plate.
- Baffle plate divides bowl into ACTIVE and QUIET zones: *active,* where separation takes place, *quiet* where moisture accumulates for draining off instead of being driven along due to exposure to air turbulence.
- Reinforced Monel wire screen stops all solids.
- Transparent bowl lets you *see it work*—shows when liquid and "goo" should be blown out bottom cock.

Norgren

Write for **DETAILED INFORMATION...** stop gambling with vital air cylinders and tools . . . KNOW that you have STOPPED the damaging moisture. C. A. Norgren Co., 222 Santa Fe Drive, Denver 9, Colorado, U. S. A.

Press Welders with
T-J CYLINDERS

HIGH OPERATING SPEEDS
LOW AIR CONSUMPTION
T-J
T-J

In these air-operated press welders manufactured by The Taylor-Winfield Corp., Warren, Ohio, T-J Cylinders contribute to the rapid and efficient operation of the machines. The cylinder is employed to move the welding head to the work and return—a job performed by T-J with *accuracy, speed* and *dependability!*

This is typical of the widespread use of T-J Cylinders today to simplify operations and save time and labor. There's a T-J Air or Hydraulic Cylinder *exactly right* for all kinds of tough jobs where pushing, pulling or lifting is needed . . . 100 lb. or 50,000 lb. Available in many standard sizes and styles . . . both cushioned and non-cushioned types. Backed by 30 years of know-how . . . T-J engineered to do the job *better* and *cut costs!* Write for latest catalogs. The Tomkins-Johnson Co., Jackson, Mich.

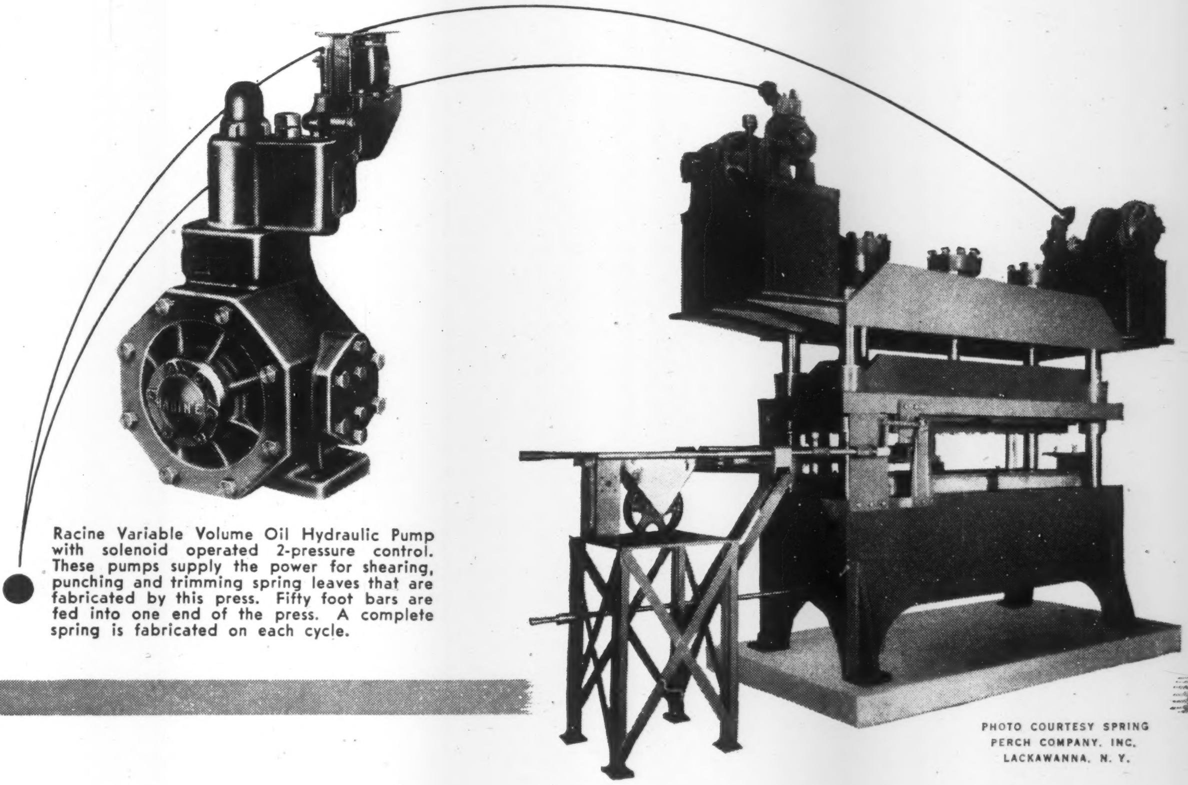
FOR POWER MOVEMENT IN ANY DIRECTION

TOMKINS-JOHNSON

RIVITORS...AIR AND HYDRAULIC CYLINDERS...CUTTERS...CLINCHORS

T-J

RACINE HYDRAULICS



Racine Variable Volume Oil Hydraulic Pump with solenoid operated 2-pressure control. These pumps supply the power for shearing, punching and trimming spring leaves that are fabricated by this press. Fifty foot bars are fed into one end of the press. A complete spring is fabricated on each cycle.

PHOTO COURTESY SPRING PERCH COMPANY, INC.
LACKAWANNA, N. Y.

Smooth Oil-Cushioned Action Under Variable Volume Control

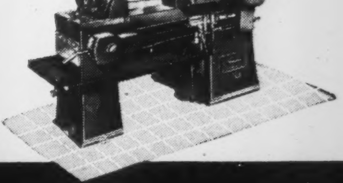
The built-in Variable Volume feature of RACINE Pumps simplifies your hydraulic circuits, reduces piping and eliminates the use of relief and by-pass valves. Your machine runs shock-free, cool and uses less horsepower. Aggregate cost of complete hydraulic assembly is substantially reduced.

RACINE users now include manufacturers of Presses, Die Casting and Plastic-Molding Machines, Drilling and Woodworking equipment, Lifts, Elevators and many additional types of machines. An impressive number have standardized on RACINE's full line of Variable Volume pumps, Sleeve Type valves and Hydraulic pressure boosters.

Let us prepare for you, a full outline of the special advantages your product can present when RACINE Hydraulic Equipment is used. Make our Variable Volume feature a part of your machine. RACINE hydraulic engineers will give you full cooperation without cost or obligation. Write today for our Free catalog P-10-C. RACINE TOOL AND MACHINE COMPANY, 1773 State St., Racine, Wisconsin.

Racine Hydraulic METAL CUTTING MACHINES

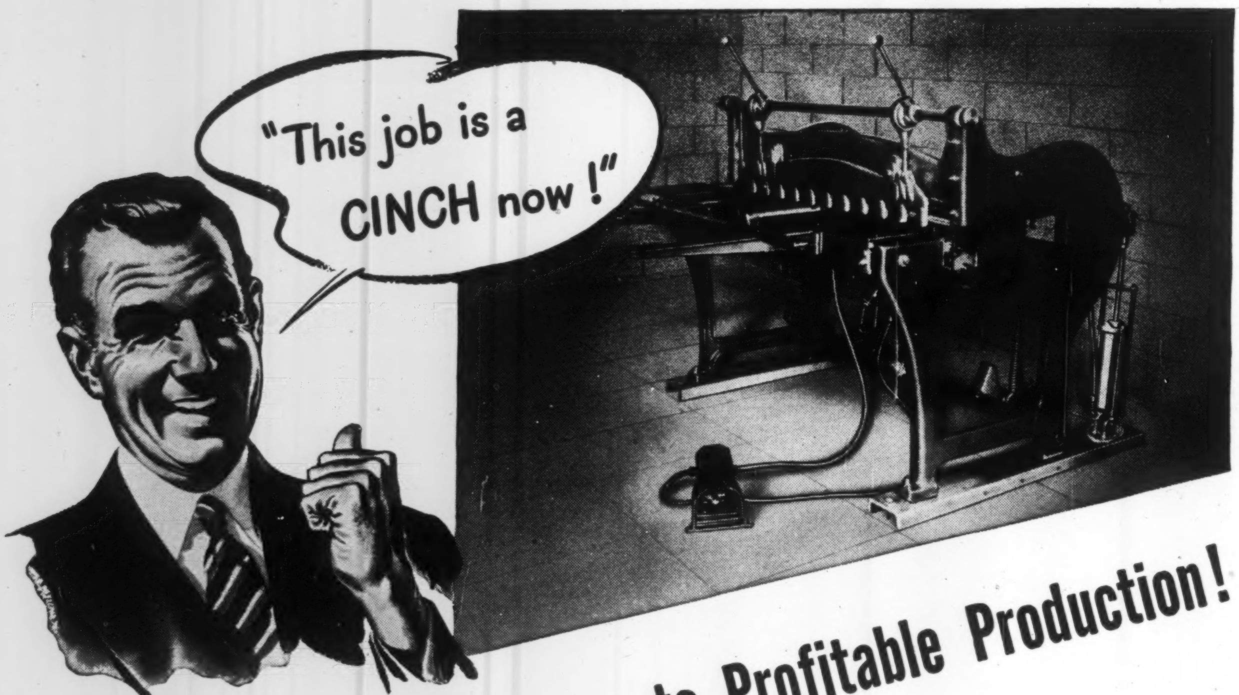
Featuring open front design—simple one lever control—smooth oil-cushioned progressive feed. Cut any metal from light tubings to structural shapes and billets of tough tool steels. Models in all price ranges. Capacities 6" x 6" to 20" x 20". Write for complete catalog No. 12.



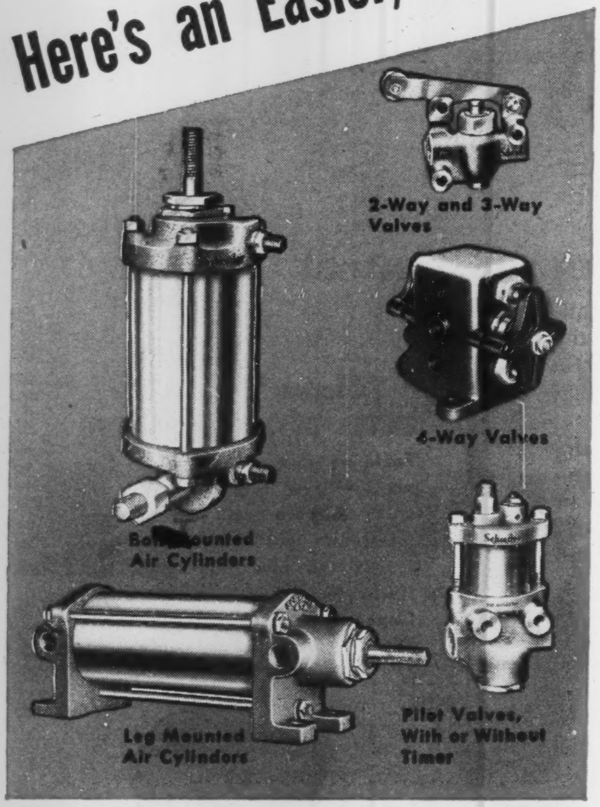
STANDARD FOR QUALITY AND PRECISION
RACINE
RACINE TOOL and MACHINE CO.

RACINE

STANDARD FOR QUALITY AND PRECISION



Here's an Easier, Quicker Answer to Profitable Production!


2-Way and 3-Way Valves
4-Way Valves
Bo[illegible]ounted Air Cylinders
Leg Mounted Air Cylinders
Pilot Valves, With or Without Timer

Can you improve production and safety of manufacturing operations quickly and easily without expensive alterations to plant or machinery?

Yes! By using compressed air, efficiently controlled by Schrader Valves and Air Cylinders, to operate your machines. Take this shearing machine for instance: by converting to air control, production is boosted, operator fatigue eliminated, and there is far greater ease and versatility of operation. Not only that but with air power you can frequently shear heavier gauge metal. This is a typical illustration of what Schrader Valves and Cylinders can do when put to work on shearing machines, power presses, welding machines, kick presses, arbor presses and many other essential machines.

Consider Schrader Valves and Cylinders as production boosters in your plant. Installation can often be made with little or no extra load in your present compressor capacity.

Schrader Air Cylinders and Valves give you efficient control of compressed air. Help you accomplish more—in less time—with less manpower used.

For further information on how these Schrader products can help you, write today to Department 9

EVERYTHING FOR EFFICIENT AIR CONTROL

Air Cylinders, Operating Valves 2, 3 and 4-way (hand, foot and remote control), Press Operating Controls, Pneumatic Machine Controls (all types), Air Ejection (Knockout) Sets, Quick Acting Couplers, Blow Guns, Air Hose and Fittings, Hydraulic Gauges.

A. SCHRADER'S SON • BROOKLYN 17, N. Y.

Division of Scovill Manufacturing Company, Incorporated

Schrader
PRODUCTS
CONTROL THE AIR

How Many Spare V-Belts Do You *Really* Need?

VEELOS "V" BELTING
LT DRIVES

With only four reels of Veelos, he has a choice of 316 standard sizes.

WHEN Veelos on reels goes into a stockroom, a costly mass of many-size endless V-belts is eliminated. Four reels of Veelos, the link V-belt, provide replacements for as many as 316 sizes.

Do you require less? From a single 100-foot reel of Veelos any length V-belt can be quickly uncoupled, made endless and installed. You need *not stock even one* spare endless V-belt. There is none to age and deteriorate. With Veelos on reels, desired belt lengths are always available, easy to locate. Stock records are simplified... storage space saved.

Veelos is available in all standard sizes, fits all standard grooves, is packaged on standard 100-foot reels. Ask about the many, exclusive advantages of Veelos on reels.

Over 300 Veelos distributors and sales engineers located in principal cities to serve you.

MANHEIM MANUFACTURING & BELTING CO.
MANHEIM, PENNSYLVANIA

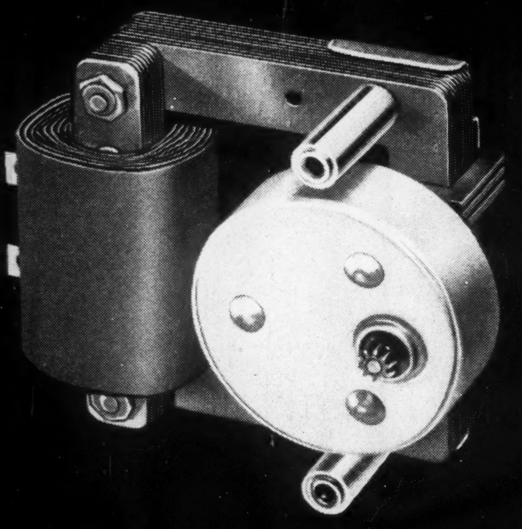
VEELOS
THE LINK
V-BELT

Adjustable to any Length
Adaptable to any Drive

Tested, Proved and Adopted by American Industry

Known as VEELINK outside the United States

a new Telechron motor for high peak loads



- Here's an entirely new synchronous electric motor. It's designed for intermittent use, such as controls on washing machines and other household appliances.

- This special-duty motor is the Telechron high peak-torque H10. Sturdily built, it has the extra stamina to handle loads far beyond its normal rated capacity. And it will keep a control device operating accurately and dependably.

- Like every Telechron synchronous electric motor, the high peak-torque H10 is self-starting and reaches rated speed almost instantly. It operates in perfect synchronism with all commercial frequencies . . . cannot run faster or slower. Precision building and Telechron's exclusive capillary oiling system assure years of trouble-free service and low maintenance cost.

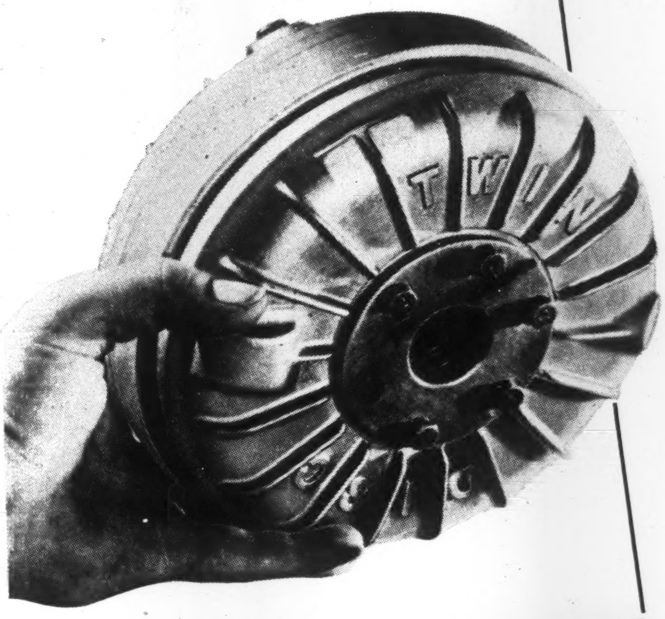
- The new H10 reflects Telechron's 25 years of leadership in engineering and producing synchronous electric motors. Telechron motors have been successfully used in clocks and timing devices for a quarter of a century—and more. They're all Underwriters Laboratories approved.

- Telechron application engineers are always glad to discuss your motor needs. For prompt action, address Motor Advisory Service, Dept. C, Telechron Inc., Ashland, Massachusetts.

Telechron
REG. U. S. PAT. OFF.
SYNCHRONOUS MOTORS

see our
CATALOG
in
SWEET'S FILE
for PRODUCT DESIGNERS

THE FIRST AND FAVORITE SYNCHRONOUS ELECTRIC TIMING MOTOR



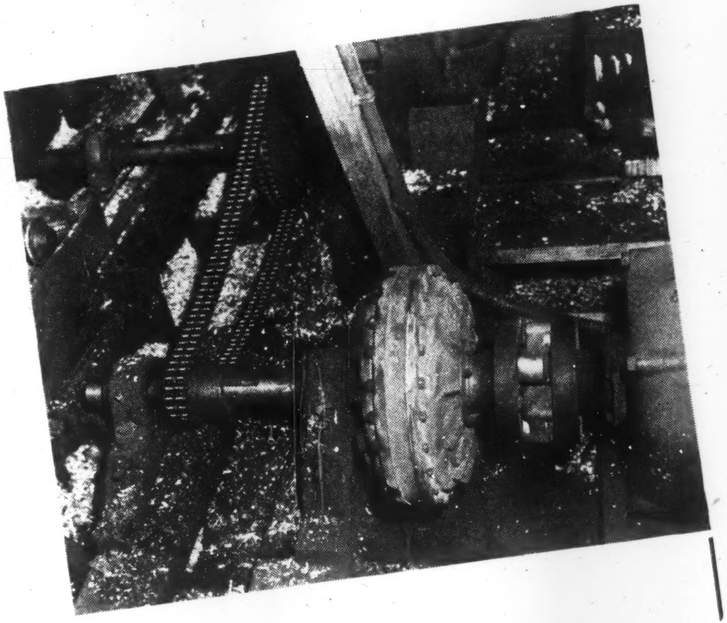
For OVERLOAD PROTECTION

The new Twin Disc Small Hydraulic Coupling . . . designed for use with electric motors or internal combustion engines developing 1 to 25 hp . . . gives you overload protection for both driving and driven parts . . . eliminates the need for shear pins and other break-and-replace devices.

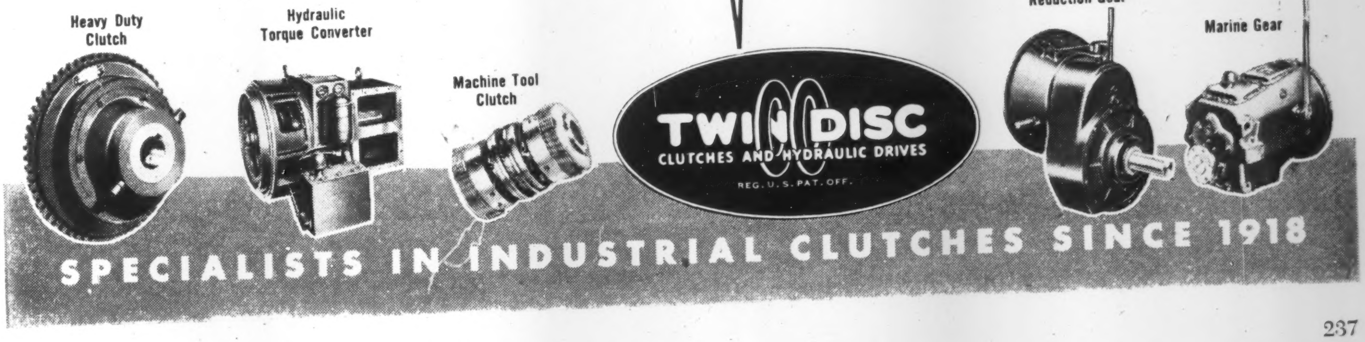
Additional advantages you can gain for your equipment by using the new Twin Disc Small Hydraulic Coupling include:

1. Motor or engine stalling will be prevented.
2. Momentary overload and heavy starting no longer will require oversize motors.
3. Shock loads, torsional vibrations, and excessive strains will be cushioned out.
4. Efficiency of multiple engine hookups or multiple drives will be increased through improved distribution of load.

These characteristics of the Twin Disc Small Hydraulic Coupling have been proved in a wide variety of applications. For descriptions and illustrations of typical applications, write to the Twin Disc Clutch Company, Racine, Wisconsin, for your copy of the "Small Hydraulic Coupling Issue" of PRODUCTION ROAD. TWIN DISC CLUTCH COMPANY, Racine, Wisconsin (Hydraulic Division, Rockford, Illinois).



This 8.4″ Twin Disc Small Hydraulic Coupling is at work on a pipe wrapping machine for the Crutcher-Rolfs-Cummings Company, Arkansas City, Kansas. It is working on a 6″ pipe-line. The Coupling has eliminated all shocks and overloads.


Heavy Duty Clutch
Hydraulic Torque Converter
Machine Tool Clutch
TWIN DISC
CLUTCHES AND HYDRAULIC DRIVES
REG. U. S. PAT. OFF.
Reduction Gear
Marine Gear
SPECIALISTS IN INDUSTRIAL CLUTCHES SINCE 1918

WELDED DESIGN

... cuts weight 1500 pounds
... cuts cost $1700

An interesting example of the wide design possibilities offered by arc welding is this windlass built by the Ideal Windlass Company of Attleboro, Mass. This giant piece of equipment represents a combination of ingenious design with sound engineering to develop a product that is strong, relatively light in weight, and inexpensive.

By combining the particular advantages of casting with the advantages of welding, the windlass was built at a 57% reduction in cost, and a 25% reduction in weight – $3,000 as against $1,300, and 6,000 pounds as against 4,500 pounds.

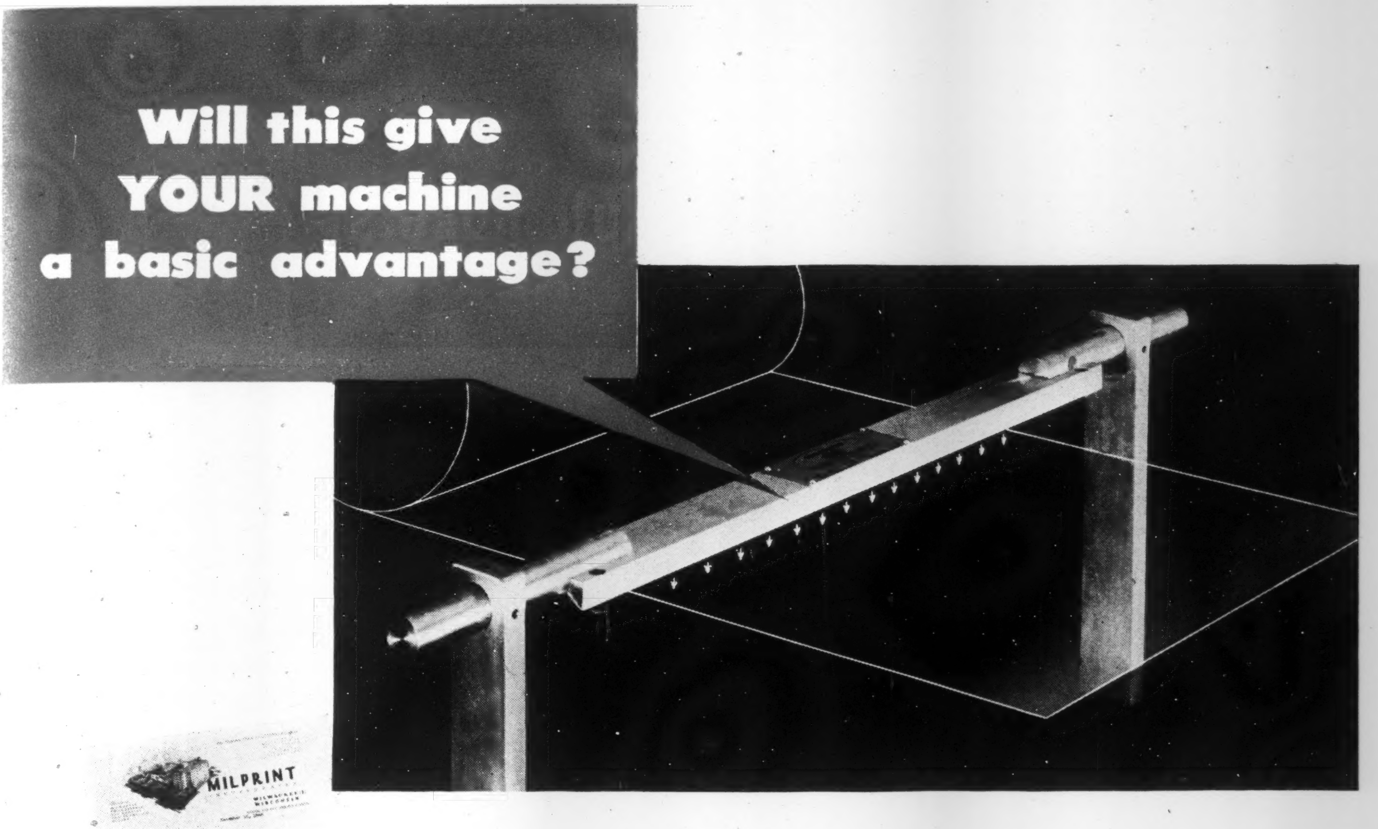
In the same way, you can effect many important economies in weight, building-time and materials by the use of oxyacetylene flame-cutting and arc welding to unite separate parts. Plan welded design for your next job.

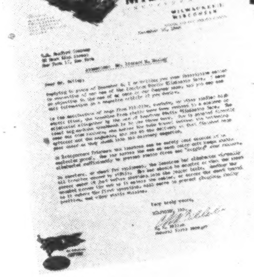
Air Reduction's Technical Sales Division will help you with any design problem concerning the use of these processes. For full details, write: Dept. MD-6114, Air Reduction, 60 East 42nd St., New York 17, N. Y. In Texas: Magnolia Airco Gas Products Company, Houston 1, Texas.

AIRCO **AIR REDUCTION**

Offices in All Principal Cities

Headquarters for Oxygen, Acetylene and other Gases ... Carbide ... Gas Welding and Cutting Apparatus and Supplies ... Arc Welders, Electrodes and Accessories




MILPRINT

Read how it has reduced static problems for a big user of packaging and printing machines

Here are excerpts from the letter above, by C. K. Billeb, General Works Manager of Milprint, Inc., Milwaukee:

"In the manufacture of bags from Pliofilm, acetate, or other similar high-static films, the troubles from static have been reduced to a minimum or eliminated altogether by the use of Ionotron Static Eliminator bars.

"On rotogravure printers, the Ionotron can be safely used because it is explosion-proof. One bar across the web at each color unit keeps static eliminated sufficiently to prevent static fires and 'hugging' over rollers.

"On sheeters, or sheet-fed equipment, the Ionotron bar eliminates virtually all troubles caused by static."

In a wide variety of machines . . . in many different industries . . . friction-generated static electricity is interrupting production or causing product irregularities, fires, or explosions. If you are designing any machine in which static is a potential source of trouble, the chances are that you can give that machine a basic sales advantage by including an Ionotron Static Eliminator* at the trouble zone.

The Ionotron contains a source of alpha radiation which continuously "bleeds-off" static charges. Its use in any machine requires no change in basic design. It requires no power connection. Its action is permanent. There are no moving parts, no maintenance problems, and no operating cost! Units can be obtained in shapes and sizes to fit individual "specs".

For information about how the Ionotron can eliminate static in the machine you're designing — or in equipment you're using — send full details of the trouble zone to *Dept. 16, U. S. Radium Corp., 535 Pearl St., New York 7, N. Y.*

Trade-mark reg. U. S. Pat. Off.

US RADIUM

IONOTRON
Static
ELIMINATOR

It's a Joy Ride for Automakers

(FOR DRIVERS AND PASSENGERS, TOO)

...with AMERICAN PHILLIPS SCREWS

that keep brakes on costs, protect performance, speed up sales

"STEP ON THE GAS" IN PRODUCTION! Why *put up* with slow, slip-and-slash, "horse-and-buggy" fastening methods when AMERICAN PHILLIPS SCREWS can be driven at TOP SPEED. But speed is only part of the story. American Phillips Screws can't be fumbled, fingers can't be mangled, work can't be wrecked. And driving is automatically straight. So . . . TOTAL TIME-SAVINGS MOUNT AS HIGH AS 50%.

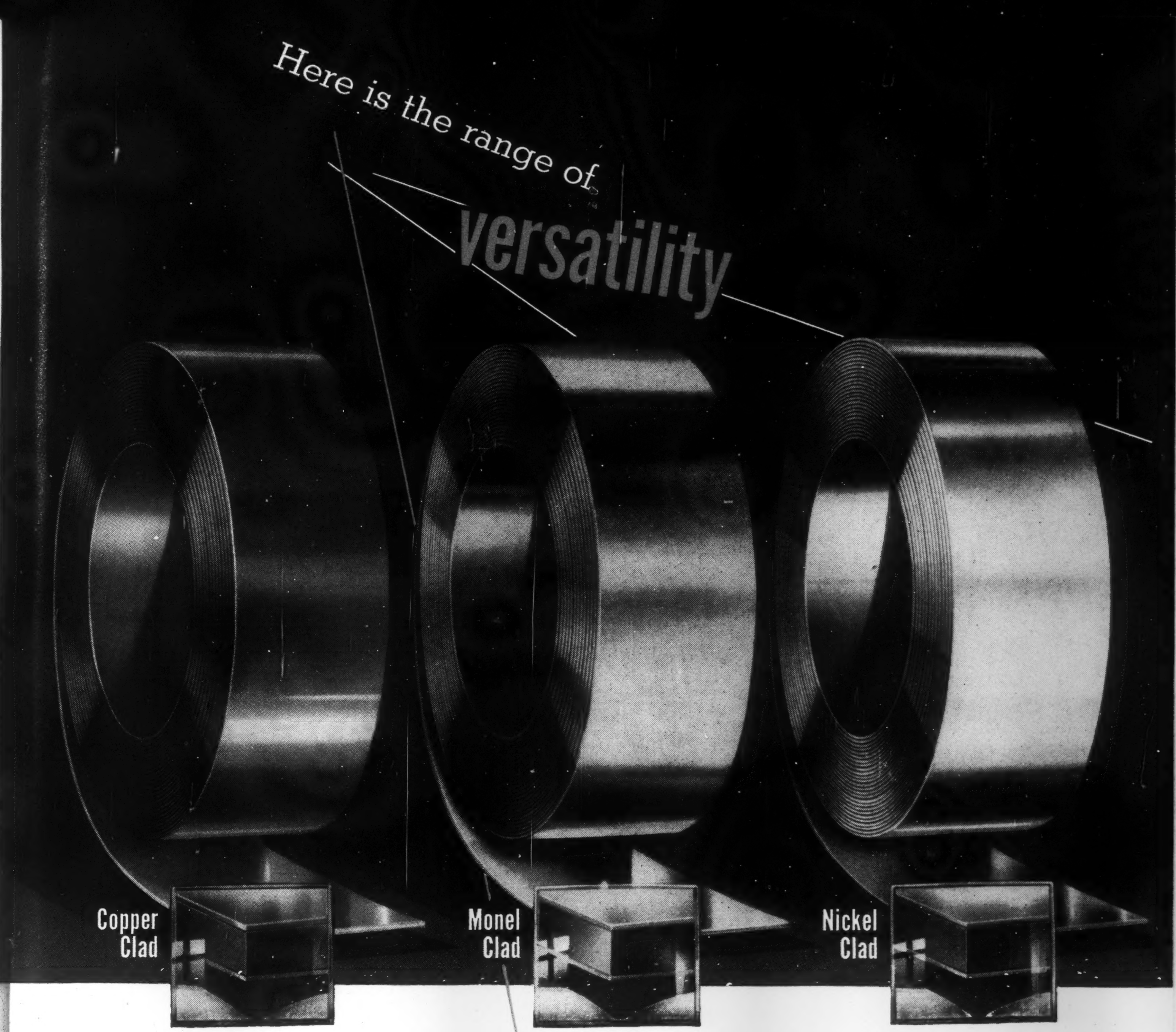
"STEP ON THE GAS" IN PROMOTION! American Phillips Screws give car, boat, appliance (or whatever you make), a "classy chassis" that means more sales thru more *show*manship! Clothes and hose can't snag. And resistance to vibration makes another talking point. There's an American Phillips Screw in any type or metal which will win these production and promotion "extras" for you, your distributors and dealers.

4-WINGED DRIVER CAN'T SLIP OUT OF PHILLIPS TAPERED RECESS

AMERICAN SCREW COMPANY, PROVIDENCE 1, RHODE ISLAND
Chicago 11: 589 E. Illinois Street *Detroit 2:* 502 Stephenson Building

AMERICAN PHILLIPS *Screws*

ALL TYPES
ALL METALS: Steel, Brass, Bronze, Stainless Steel, Aluminum, Monel, Everdur (silicon bronze)



in

SuVeneer* CLAD METAL

*Trademark Reg. U. S. Pat. Off.

The *face values* of any of three metals—copper, monel or nickel—are yours *plus* the physical characteristics of steel . . . when you specify SuVeneer* Clad Metal!

In a single composite strip, you get the solid, dense metal you choose on *one side or both sides* of the steel base . . . in controlled thickness, inseparably bonded, retaining its relative proportions in all gauges.

SuVeneer Clad Metal can be drawn, formed or stamped by your customary processes. It is a material well worth the immediate attention of modern metal fabricators in every field. Your detailed inquiries are welcome!

Specialists
in the production of fine strip steels since 1892

- **SuVeneer Clad Metal**
- **Stainless in all grades**
- **Alloys and Spring Steels**

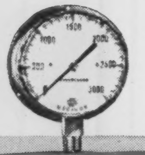
Superior Steel
CORPORATION
CARNEGIE, PENNSYLVANIA

An Instrument of Tomorrow

BETTER INSIDE . . . BETTER OUTSIDE . . . BETTER ON THE FACE OF IT

1500
2000
1000
2500
500
3000
0
SUPERGAUGE
USG
U.S. GAUGE

. . . . Here Today



U.S. INSTRUMENTS Tell The Truth

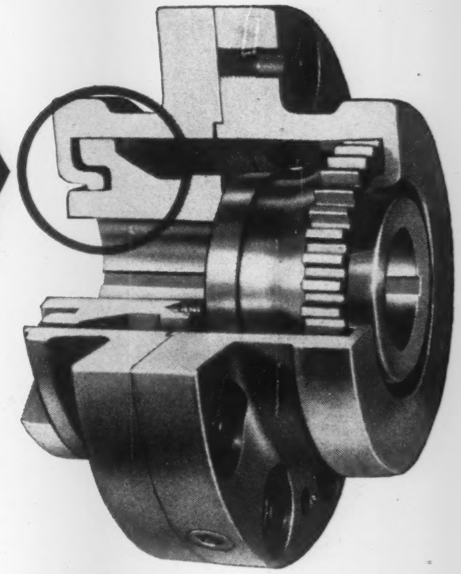
UNITED STATES
GAUGE

THE NEW USG SUPERGAUGE—is an instrument of test gauge accuracy, a gauge specially designed for long years of service in industrial installations where excessive vibration, pulsation and high temperature are present. It provides the safe, accurate, economic check on process control that engineers demand. Modernly styled, it has clean trim lines and an easy-to-read broad face dial with bold sharp figures and graduations. Furnished in 4½″, 6″, and 8½″ dial sizes. Buy reasonably priced Supergauge today.

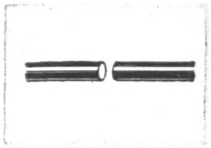
DIVISION OF AMERICAN MACHINE AND METALS, INC. SELLERSVILLE, PA.
Manufacturers of Pressure, Temperature, Flow and Electrical Measuring Instruments

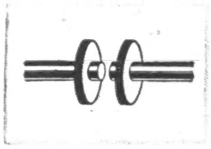
USG

Specify FAST'S—Get This EXTRA Protection *Against* COUPLING SHUTDOWNS



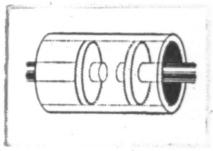
Metal-to-Metal Seal Keeps Oil Clean for Continuous Service!

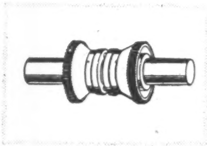


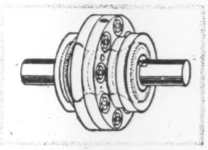


Fast's Couplings Are Simple as A-B-C

See the simple development of Fast's Couplings. A splined hub on each shaft end, a sleeve with internal splines to mesh. Oil in the sleeve carries the load between the splines.

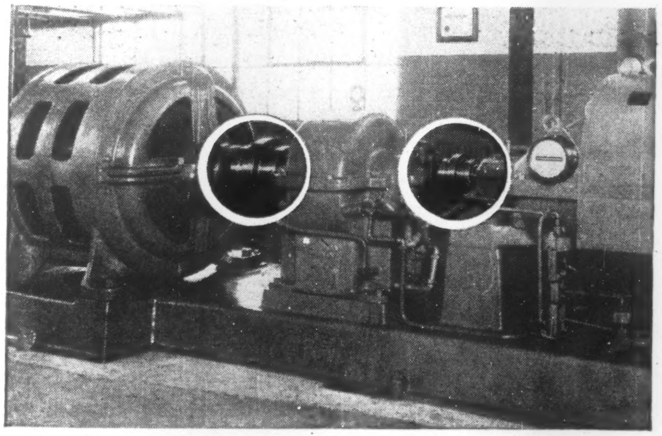






You can trust Fast's, the *original* gear-type coupling, which eliminated the need for *perishable* parts! The load-carrying oil in a Fast's Coupling is guarded by a positive metal-to-metal seal . . . the *exclusive* "rocking bearing" shown in the circle. The oil is kept free of moisture, dust and grit. No perishable packing rings are used. That's why you get *uninterrupted* power transmission with Fast's.

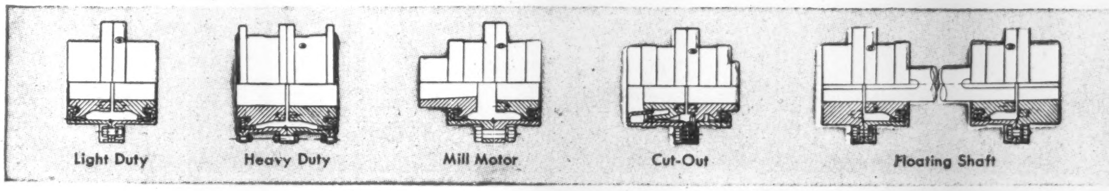
When you buy Fast's Couplings, you buy many years of top engineering experience, Koppers' high standard of workmanship and unexcelled coupling service. It will pay you to install Fast's . . . for longer machine life, lower upkeep costs, minimum shutdown losses. Write today for our complete catalog to: Koppers Company, Inc., Fast's Coupling Dept., 256 Scott St., Baltimore 3, Maryland.



HIGH H.P. at HIGH R.P.M.—These No. 3 and No. 5 Fast's Couplings connect a turbine-reduction gear-generator hookup, 1125 h.p. at 3740/1200 R.P.M., at Firestone Steel Products Co., Akron, Ohio.

K KOPPERS

FAST'S
self-aligning
COUPLINGS



OTHER TYPES:
Jordan
Single Engagement
Shear Pin
Breaking Pin
Continuous Lubricating
Collector Ring
Vertical.

Seamless and Welded

CALL ON CROLOY

STAINLESS STEEL TUBES

...all kinds for EVERY mechanical use from

ONE SOURCE

ALL THESE AND MORE

- Croloy 12
- Croloy 12-Al
- Croloy 16
- Croloy 18
- Croloy 22
- Croloy 27
- Croloy 18-8S
- Croloy 20-10
- Croloy 18-8Ti
- Croloy 18-8Cb
- Croloy 16-13-3
- Croloy 18-13-3
- Croloy 25-20

Physical and mechanical properties, application and fabricating data, and other pertinent information on B&W Croloy Stainless Steel Tubing are contained in Technical Bulletin No. 1. Would you like a copy?

B&W is the logical place to come for your Stainless Tubing requirements for any mechanical use for several sound reasons:

...B&W makes BOTH Seamless and Welded Stainless Tubing.

...B&W offers you the widest range and number of ferritic and austenitic analyses available from a single source . . . many of them available from no other supplier.

...B&W produced the first Stainless Tubing commercially in America; therefore has acquired a wealth of experience and data which users will find helpful in selecting the Stainless analysis best suited for any application. All B&W Stainless Tubing can be furnished in any standard finish. More information on Croloy Stainless Tubing is available in Bulletin No. 1.

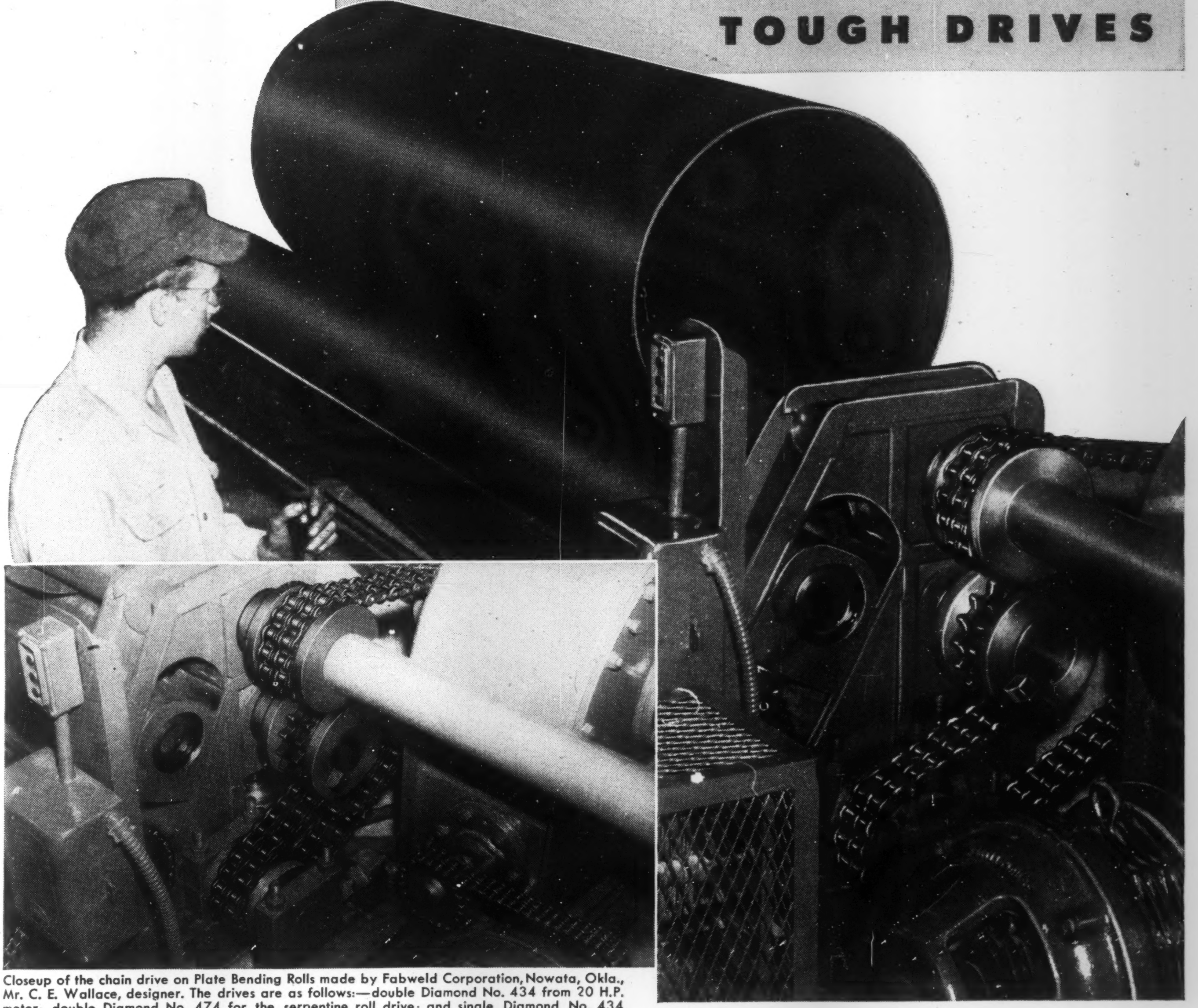
TA-1407S

BABCOCK & WILCOX

SEAMLESS & WELDED TUBES

THE BABCOCK & WILCOX TUBE COMPANY
GENERAL OFFICES: BEAVER FALLS, PA.
PLANTS: BEAVER FALLS, PA. AND ALLIANCE, OHIO.

BENDING PLATE REQUIRES TOUGH DRIVES



Closeup of the chain drive on Plate Bending Rolls made by Fabweld Corporation, Nowata, Okla., Mr. C. E. Wallace, designer. The drives are as follows:—double Diamond No. 434 from 20 H.P. motor; double Diamond No. 474 for the serpentine roll drive; and single Diamond No. 434 from the 7½ H.P. motor to adjusting screws.

To shape and cold-roll plate up to ⅜" thick and 10 feet long is a job requiring positive drives of great reserve strength.

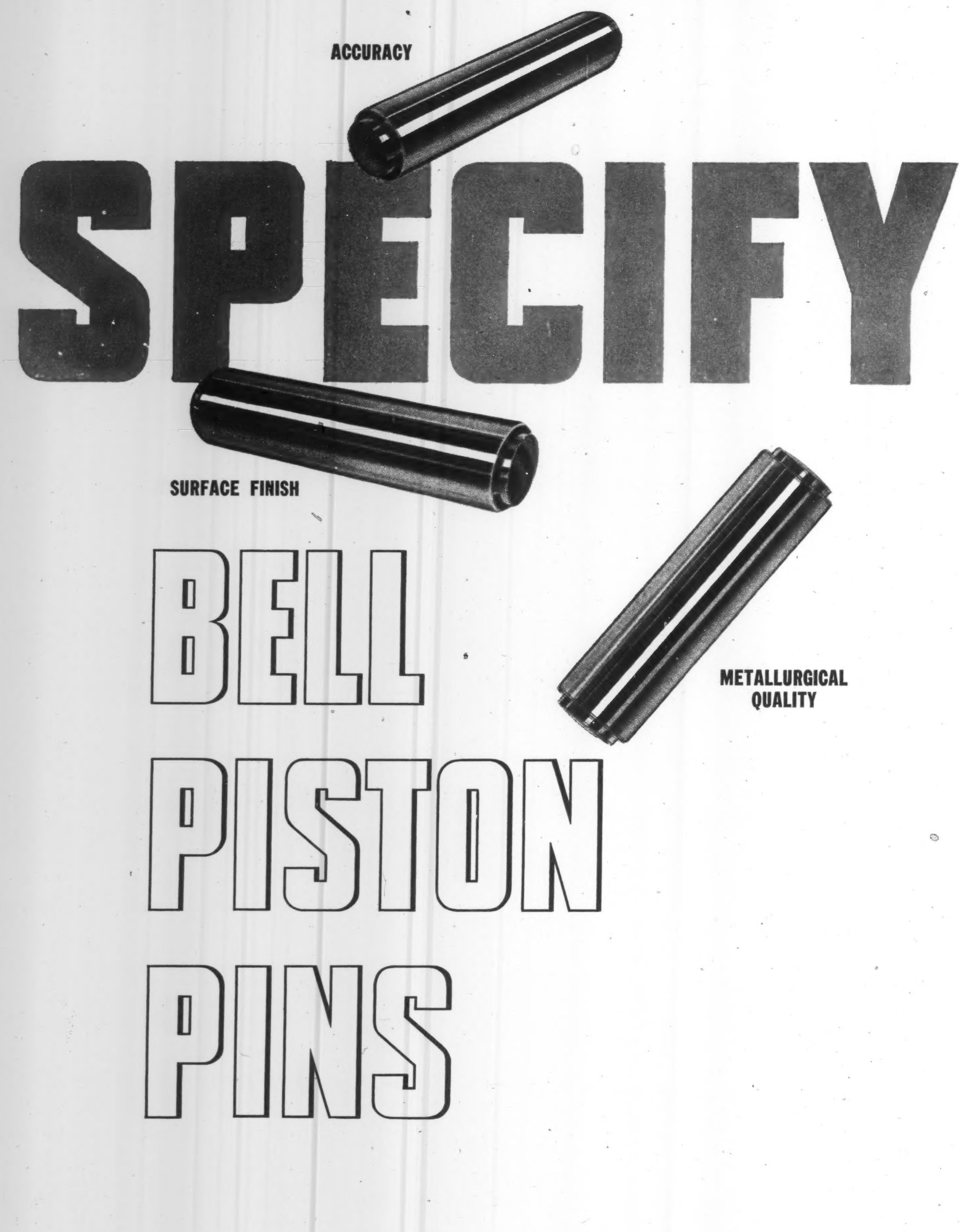
Diamond Roller Chains are doing the job, —driving the roll shafts from a 20 H.P. motor through a reducer. To obtain the proper relative rotation of the rolls a serpentine drive is required, easily accomplished because both sides of Diamond Roller Chain are alike.

To drive the rear roll which determines the diameter, another Diamond Drive operates adjustable screws.

When considering improvements in present design and new machines, experienced Diamond engineers are ready at all times to make practical recommendations. Such help can save valuable time. DIAMOND CHAIN COMPANY, Inc., Dept. 435, 402 Kentucky Avenue, Indianapolis 7, Indiana. Offices and Distributors in All Principal Cities.

DIAMOND ROLLER CHAINS

The drive data in Catalog No. 617 can help you. Copy on request.



ACCURACY

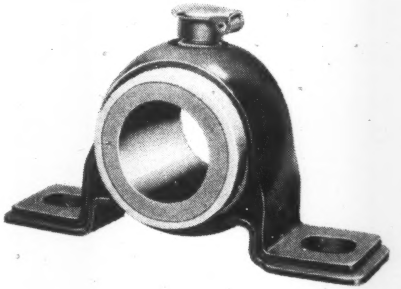
SPECIFY

SURFACE FINISH

METALLURGICAL
QUALITY

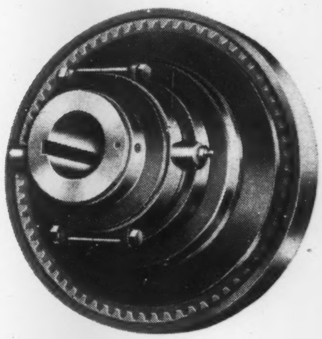
BELL
PISTON
PINS

MANUFACTURED BY BELL ENGINEERING, KNOXVILLE, TENNESSEE



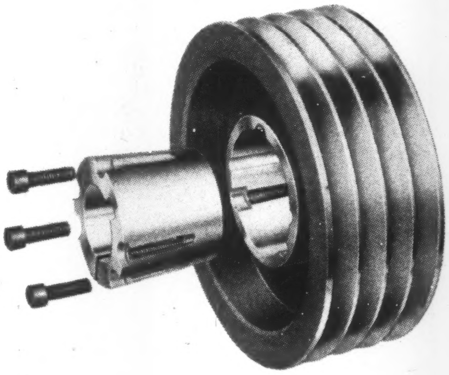
This is the BRONZOIL Bearing. Developed by Dodge for fan and blower service. A new and better transmission appliance.

U. S. Patent No. 1,931,055



This is the ROLLING GRIP Clutch. Developed by Dodge. No toggles. A new and better transmission appliance.

U. S. Patent No. 2,397,414



This is the TAPER-LOCK Sheave. Developed by Dodge. No flange. No collar. A new and better transmission appliance.

U. S. Patent No. 2,402,743

This is the Dodge Transmissioneer — who will tell you about new ways of transmitting power mechanically.

DODGE

of Mishawaka, Ind.

New equipment which helps cut costs, improve machine performance, increase production is offered to you by Dodge of Mishawaka. For detailed information about power transmission units to meet specific needs in your plant, or on your product, call the Transmissioneer, your local Dodge distributor. Look for his name in the classified telephone directory under "Power Transmission Equipment." A talk with him will prove profitable to you.

DODGE MANUFACTURING CORP., MISHAWAKA, IND.

Copyright, 1947, Dodge Mfg. Corp.

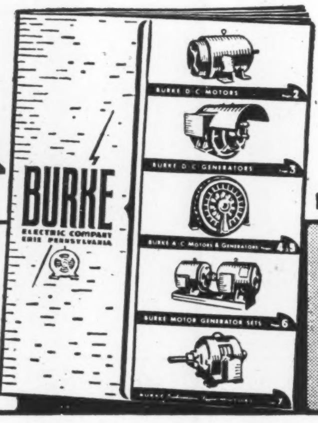
NAME PLATES

FOR YOUR NAME PLATE REQUIREMENTS, WRITE OUR SUBSIDIARY, ETCHING COMPANY OF AMERICA, 1520 MONTANA STREET, CHICAGO 14, ILLINOIS

What can BURKE do for Me?

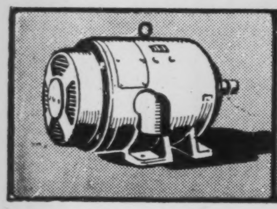
BURKE A.C. GENERATORS
MEDIUM AND HIGH SPEED
BURKE ELECTRIC CO., ERIE, PA.
BURKE POLYPHASE
1 to 1500 H.P. INDUCTION MOTORS
BURKE ELECTRIC COMPANY · ERIE, PA.
BURKE
DIRECT CURRENT Generators
ENGINE TYPE · DIRECT DRIVE · BELT DRIVE
BURKE ELECTRIC COMPANY · ERIE, PA.
BURKE
A. C. SYNCHRONOUS GENERATORS for Diesels
BURKE ELECTRIC COMPANY · ERIE, PENNSYLVANIA
BURKE HIGH CYCLE MOTOR GENERATOR SETS
BURKE ELECTRIC CO., ERIE, PA.
OFFICES IN PRINCIPAL CITIES
BURKE
A. C. SYNCHRONOUS MOTORS for Compressors
BURKE ELECTRIC COMPANY · ERIE, PENNSYLVANIA
BURKE TERMINAL BLOCKS
BURKE ELECTRIC COMPANY · ERIE, PA.

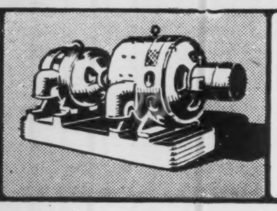
Burke is now in production on an improved line of cool running drip-proof induction motors which are fully standardized, in NEMA frame sizes 203 to 505. Cooling air enters at both ends, below centerline over the sealed bearings and is baffled to scrub the entire interior of the motor and is discharged at each side below the centerline. These are the coolest running induction motors that we have built in 41 years, and incorporate a 30 year experience with welded steel plate frame construction. Write for bulletin D-1.


BURKE
ELECTRIC COMPANY
ERIE PENNSYLVANIA
BURKE D-C MOTORS
2
BURKE D-C GENERATORS
3
BURKE A-C MOTORS & GENERATORS
4-5
BURKE MOTOR GENERATOR SETS
6
7

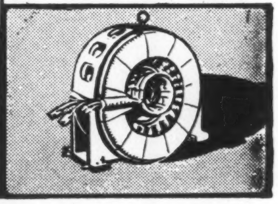
⇨ ⇨ For quick reference to the Burke line, see Sweet's Catalog File and Electrical Buyers' Reference Catalog.

BURKE ELECTRIC COMPANY 1976 WEST 12TH STREET ERIE, PENNSYLVANIA





D. C. Equipment to 1500 H. P. and 1000 K. W.
A. C. Equipment to 1500 H. P. and 1000 K. W.
M-G Sets to 1000 K. W.
Molded Bakelite Terminal Blocks



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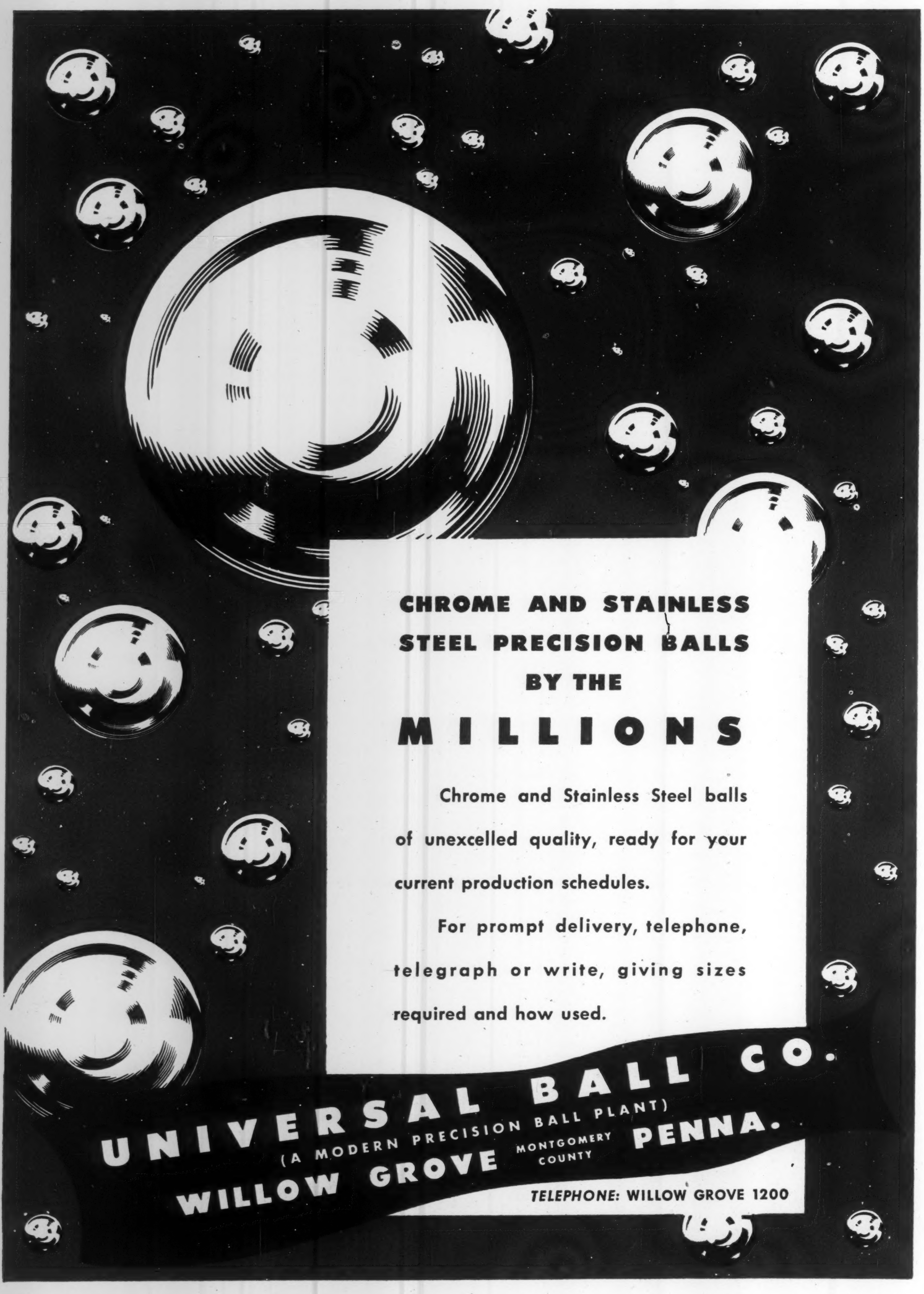

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MILLIONS

Chrome and Stainless Steel balls of unexcelled quality, ready for your current production schedules.

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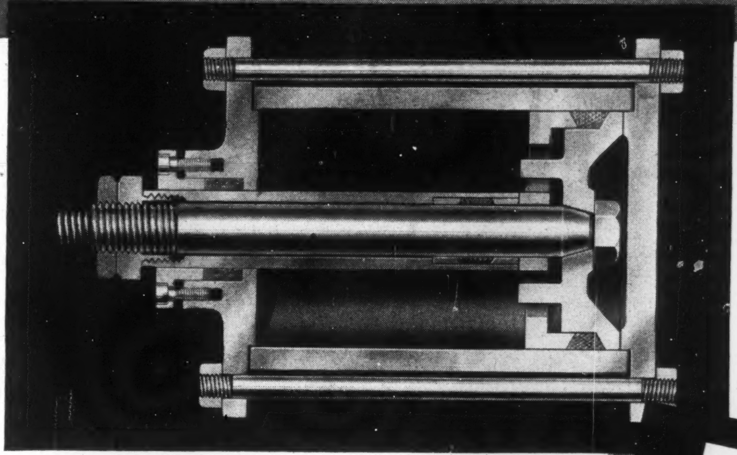
(A MODERN PRECISION BALL PLANT)
WILLOW GROVE MONTGOMERY COUNTY **PENNA.**

TELEPHONE: WILLOW GROVE 1200

HANNIFIN

Standardized—

to save you TIME and MONEY



THE HANNIFIN line of pneumatic cylinders is complete! For quicker delivery and maximum economy, you can meet virtually any requirement with a standard Hannifin precision-built cylinder.

- —Ten standard bore diameters to choose from, ranging from 1 inch to 12 inch.
- —Six basic mounting styles. Also available in double end styles.
- —Any stroke you specify. Double acting or single acting.
- —With or without adjustable cushioning for head cap . . . rod cap . . . or both.

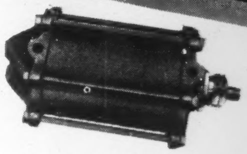
For the complete story, ask for a copy of Hannifin Bulletin No. 57-M.

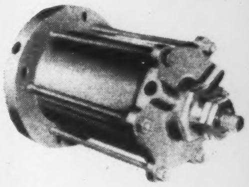
PNEUMATIC *"leakproof"* CYLINDERS

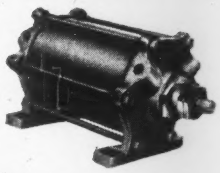
PRECISION CONSTRUCTION. Tru-bored from steel cylinder stock. Honed to satin finish by exclusive Hannifin long stroke honing process.

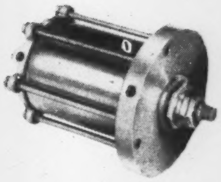
EASY MAINTENANCE. Series "R" cylinders (illustrated above) feature Hannifin's exclusive external adjustment design which permits tightening piston packing without disturbing any internal parts.

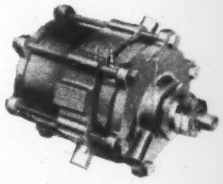
"HIGH EFFICIENCY" PERFORMANCE. With Hannifin's graphite-treated piston packing, perfect cylinder finish, and quick, positive adjustment of piston seal, you get a combination that can't be beat for smooth operation . . . low friction loss . . . freedom from air waste!

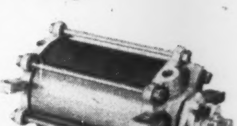


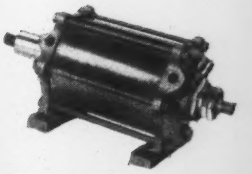


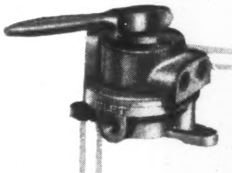












"Packless"

AIR CONTROL VALVES

Good air cylinders deserve good operating valves! For the best, use Hannifin "Packless" Air Control Valves. Complete line of hand and foot operated models. Bronze disc, grounded and lapped with body, makes perfect, long-life, leakproof seal. See Hannifin Bulletin No. 57-M.

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AIR CYLINDERS • HYDRAULIC CYLINDERS • HYDRAULIC PRESSES
PNEUMATIC PRESSES • HYDRAULIC RIVETERS • AIR CONTROL VALVES

Gas Tanks bonded by Reliable

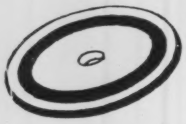
THE
MERCURY
ROCKET
Manufactured by
KIEKHAEFER CORPORATION
Cedarburg, Wisconsin

. . . an important sales feature in this powerful outboard motor

A two-piece cast aluminum gas tank permanently bonded with synthetic materials is one reason why the Mercury is a better motor . . . the tank is dent proof, leak proof and rust proof. These advantages would be lost if the tank were designed and fabricated another way. However, bonding metal-to-metal isn't exactly simple. It takes special skill, know-how, and the kind of experience that Reliable has . . . If you are not aware of the great possibilities of lowering your product cost and improving its quality through the use of bonding metal-to-metal or metal-to-another material, you should check into it today.

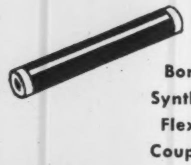
A Reliable engineer will gladly discuss the details with you and apply his experience to your application problems. Invite him to call.

OTHER EXAMPLES of Reliable Bonding



2-piece bonded micarta Gear Blank

Bonded Synthetic Compression Spring



Bonded Synthetic Flexible Coupling

Bonded Synthetic Friction Drive

Bonded Synthetic Special Rollers

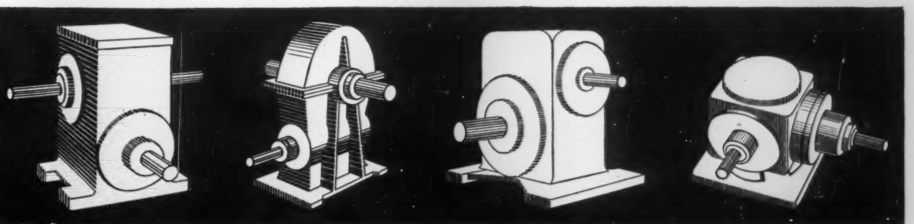
RELIABLE MOLDED PRODUCTS COMPANY

2815-21 Irving Park Road
Chicago 18, Illinois

What Speed Reducer shall I use?

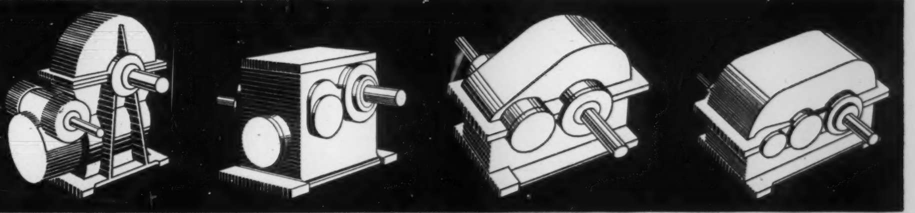
FOR RIGHT ANGLE DRIVES

When you want your driving or motor shaft at right angles with your driven shaft, use any one of these Boston Reductors. Select from these four types depending upon the horsepower or ratio required and the proper type for your application.



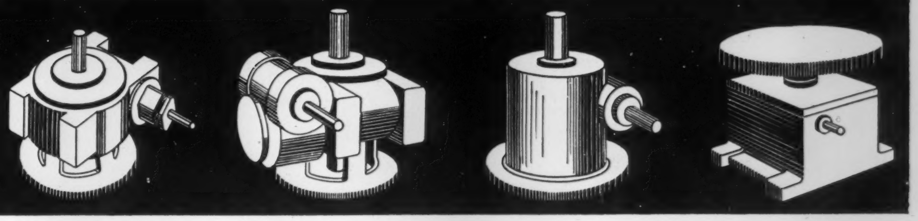
FOR PARALLEL SHAFTS

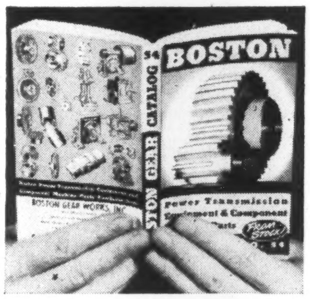
If you desire your driving or motor shaft to be parallel with your driven shaft, use one of these four types. These first two types are double reduction worm and worm gear drives with gear ratios from 16 to 1 as high as 4000 to 1.



FOR VERTICAL DRIVES

You may want a vertical reduction unit for a mixer, conveyor, etc. or where your driven shaft must be vertically up and/or down. These first three types will give you such a versatile drive. The fourth type is strictly a turntable only.





SELECTION A 12-page Reductor or Speed Reducer Selection Chart is included in our General Catalog 54. It contains complete selection data on our Reductors and gives output speeds and gear ratios available, as well as the horsepower motor to use on the Input Shaft of the Reductor. This Selection Chart includes practically all ratios, types and stock sizes available.

DIMENSIONS Complete specifications and dimensions on all Boston Reductors are given in our Catalog 54. If you have a copy of this catalog, you can easily design your drive from the complete dimensions we give you. On some of our Reductors, dimensions are given for elongated Output Shafts which are available as standard assembly. In other cases our speed reducer shafts can project in various other positions as indicated in our catalog.

ORDERING Each and every Boston Reductor has a Catalog Number. No ordering by complicated details after you select whatever ratio, size or type of Reductor you desire. Simply order by Catalog Number.

GENERAL CATALOG If you have need for any speed reduction units in your plant you should have a copy of our 320-page General Catalog 54. It contains complete specifications, dimensions and list prices on all our Power Transmission Equipment and Component Machine Parts — 50 pages of this catalog being devoted to the 12 Reductor types shown above.

BOSTON GEAR WORKS, INC.,
NORTH QUINCY 71, MASS.

BOSTON GEAR WORKS, INC., NORTH QUINCY 71, MASS.
Please send me................copies of your General Catalog 54.

NAME______________________________

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STREET______________________________

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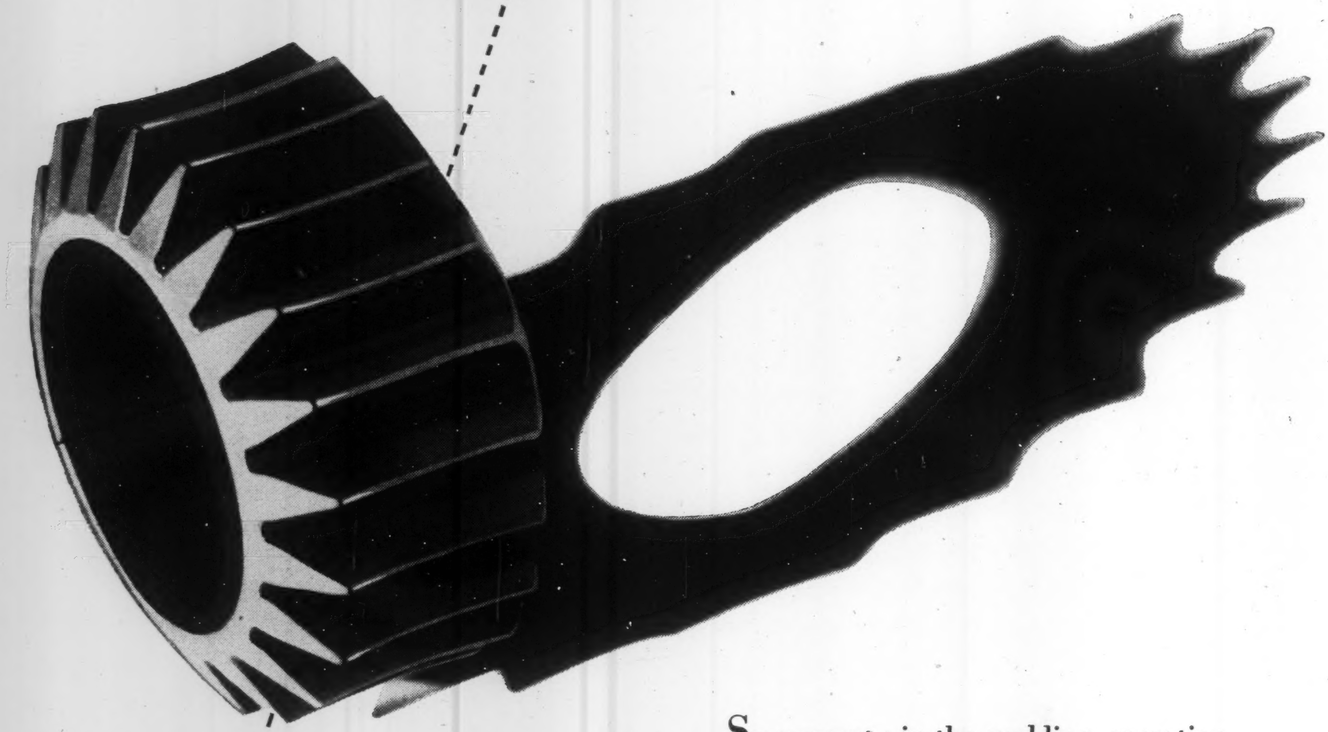
IS THIS A RUBBER *Gear?*



Specify Western Felt available in rolls, sheets, cut and treated parts to close specifications. Also impregnated and coated with synthetic rubber, resins, etc.

So accurate is the molding operation on this Acadia Synthetic rubber part it closely resembles steel.

This job is typical of the superlative workmanship that has created the high reputation of all Acadia Synthetics—rubber and plastics. They are available to close tolerance in almost any required shape or size—cut, molded to exact degrees of elasticity, resilience, and resistance to light, air, oil, age, etc. Acadia engineers are eager to cooperate with you on *your* problem.

DIVISION OF WESTERN FELT WORKS

ACADIA *Synthetic* **PRODUCTS**

Processors of Synthetic Rubber and Plastics
Sheets · Extrusions · Molded Parts
Largest Independent Manufacturers and Cutters of Felt

DIVISION WESTERN FELT WORKS

4035-4117 Ogden Avenue • Chicago 23 • *Branch Offices in All Principal Cities*

PLAN *with* BALDOR

Your Engineering Staff PLUS Baldor Motor Specialists make a good strong team.

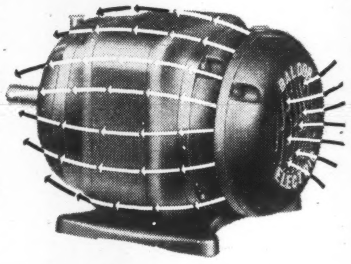
In planning new products and redesigning equipment, let the helpful cooperation of the Baldor Engineering Staff serve as a supplementary section of your own Engineering and Production Departments.

In our quarter-century of diversified motor-applications experience, we have probably solved — for other manufacturers — the very problems that now confront you on your drawing boards.

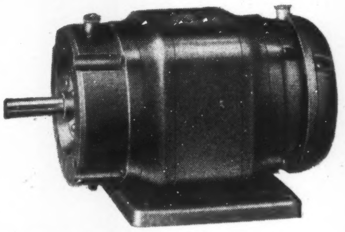
PLAN WITH BALDOR — the Better Motor for a Better Product.

BALDOR ELECTRIC COMPANY, 4353 Duncan Ave., ST. LOUIS 10, MO.

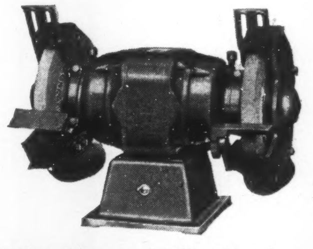
District Offices in Principal Cities



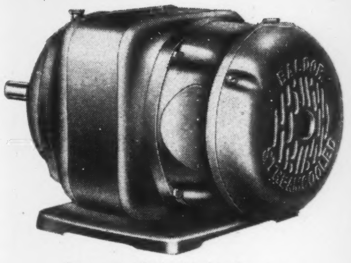
Streamcooled, polyphase, 1 to 20 h.p. (arrows indicate forced air cooling over entire exterior of motor frame).



Streamcooled face mounted; 1 phase, 3 phase and direct current.

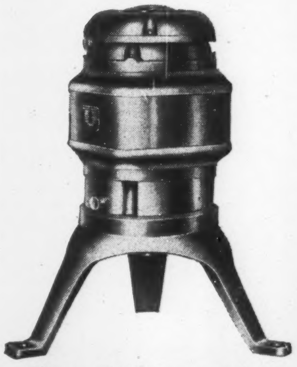


Baldor builds a complete line of bench and pedestal type Grinders, 6″ to 12″ wheels, 1/4 to 3 h.p., including a special Carbide Tool Grinder.

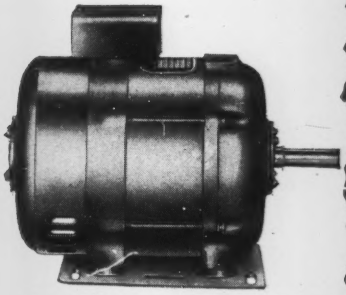


Streamcooled, single phase, 3/4 to 7 1/2 h.p.

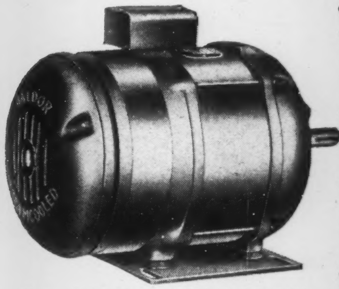
Streamcooled, direct current, 1 to 5 h.p.



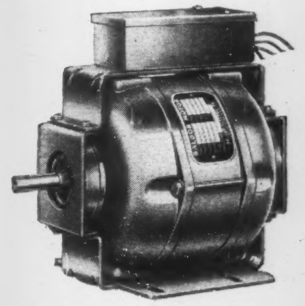
Streamcooled, face-mounted with tripod; for vertical mounting.



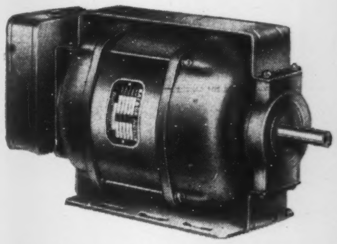
Open, drip-proof construction; 1/6 to 1/3 h.p., 1 phase, 3 phase and direct current.



Streamcooled, round frame, 1/3 to 3/4 h.p., 1 phase, 3 phase and direct current.



Resilient-mounted, open, drip-proof, for belt drive; 1/10 to 3/4 h.p., single phase.

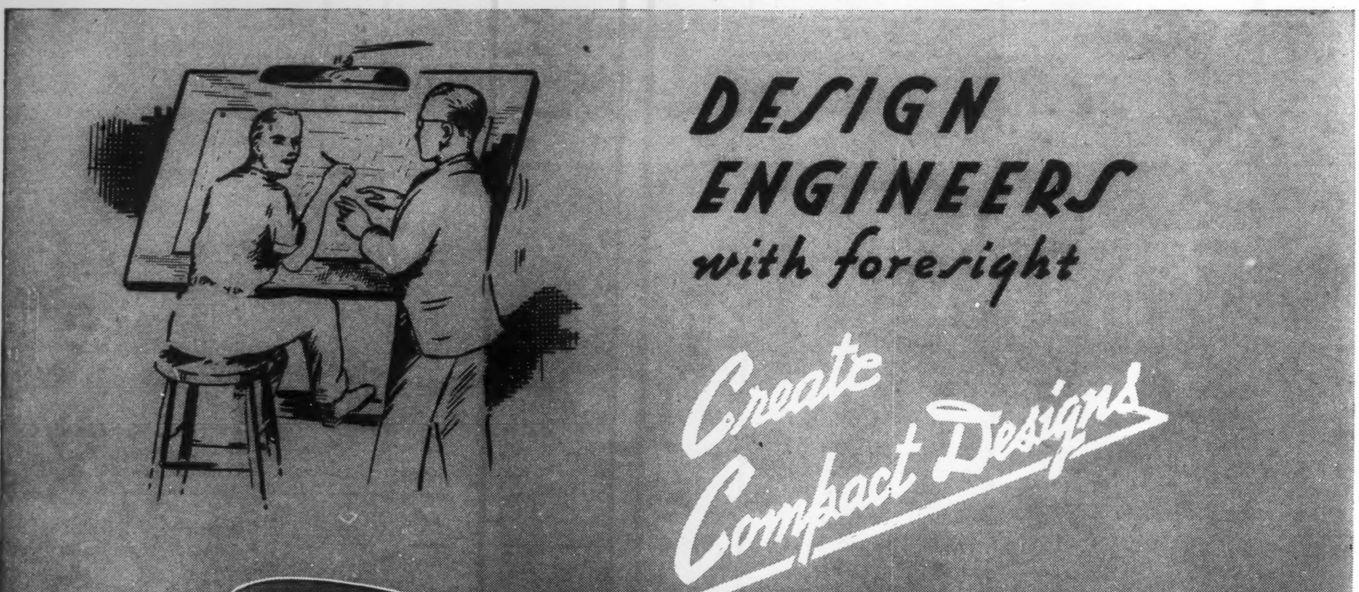


Resilient-mounted fan motor 1/30 to 1/2 h.p., 1 phase; 1/8 to 1/2 h.p., 3 phase.

Baldor

BETTER MOTORS

FOR MORE THAN A QUARTER OF A CENTURY


DESIGN ENGINEERS
with foresight
Create Compact Designs

SOCKET HEAD CAP SCREW

HOLO-KROME

fibro forged

INTERNAL SOCKET SCREWS WRENCHING

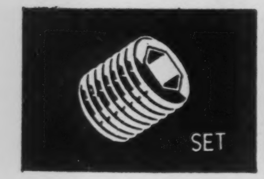
The Internal Wrenching feature permits the saving of Weight - size of members reduced. . . Saving of Space - minimum clearance for internal wrenching plus fastening placed at desired location. . . . Saving of Assembly Time - quick and positive tightening increases speed of assembly.

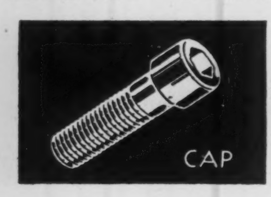
Holo-Krome Socket Screw Products are scientifically heat treated to develop, in their correct proportion, the various physical properties inherent in the special analysis alloy steel used in the manufacture of Holo-Krome FIBRO FORGED Screws - the Completely Cold Forged Screws.

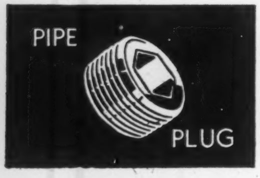
Your Holo-Krome Industrial Distributor is ready to serve you from his warehouse stock.

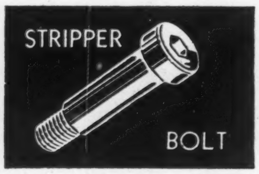
GUARANTEED Unfailing PERFORMANCE

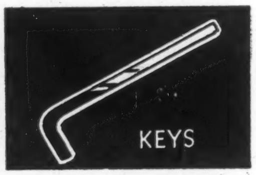
THE **HOLO-KROME** SCREW CORP. HARTFORD 10, CONN., U. S. A.

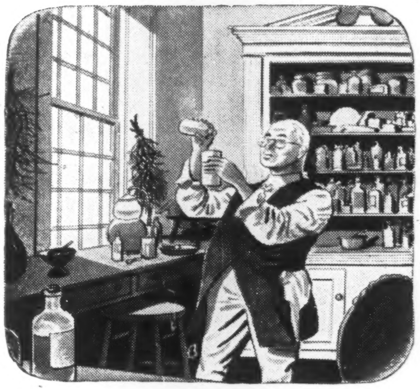




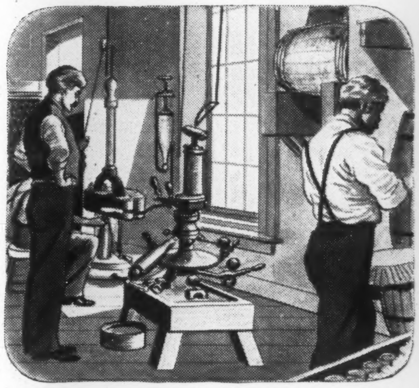



STRIPPER BOLT

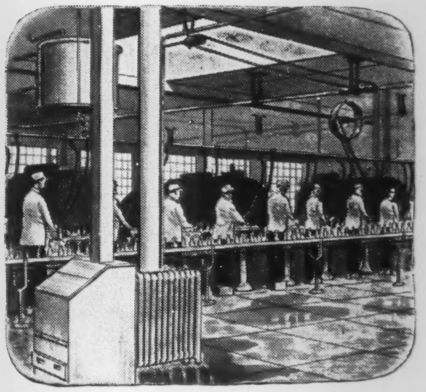




1 **1785**—Townsend Speakman, druggist, at the suggestion of one Dr. Physick, produced an artificially carbonated water for its health value. Soon, fruit juices were added for flavor and the soft drink business was under way in America.

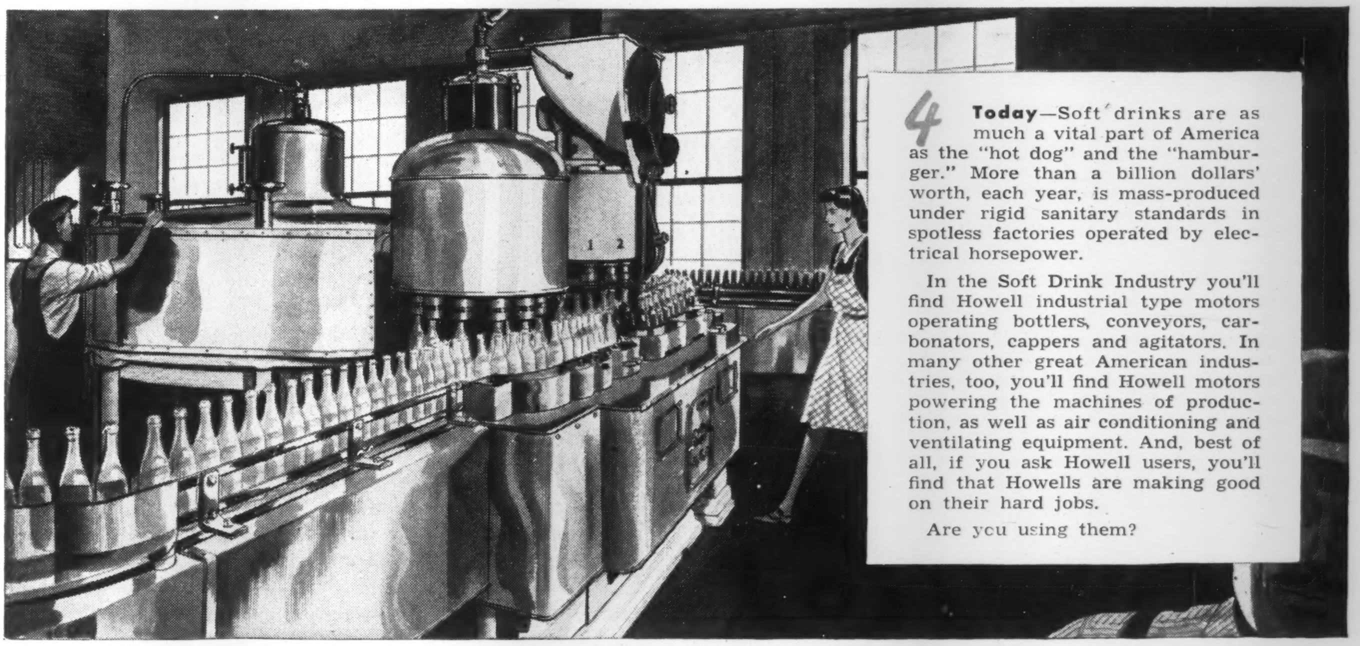


2 **1880**—Bottling machines looked like this. Work was mostly by hand in crude workshops. People went for the new "pop", not only as a beverage, but as a "cure" for gout and many other ailments. New methods were still to come.



3 **1915**—Howell engineers began working with machinery manufacturers to apply industrial type motors, specially designed, for the particular applications in bottling. Soon Howell "Red Band" Motors appeared in this and many other industries.

Then, "Pop" became a billion dollar business!

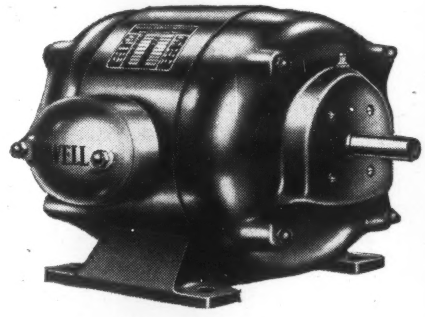


4 **Today**—Soft drinks are as much a vital part of America as the "hot dog" and the "hamburger." More than a billion dollars' worth, each year, is mass-produced under rigid sanitary standards in spotless factories operated by electrical horsepower.

In the Soft Drink Industry you'll find Howell industrial type motors operating bottlers, conveyors, carbonators, cappers and agitators. In many other great American industries, too, you'll find Howell motors powering the machines of production, as well as air conditioning and ventilating equipment. And, best of all, if you ask Howell users, you'll find that Howells are making good on their hard jobs.

Are you using them?

Be wise—buy industrial type Howell Motors! They're designed for the toughest operating conditions in industry; consequently, they perform better on *all jobs!*

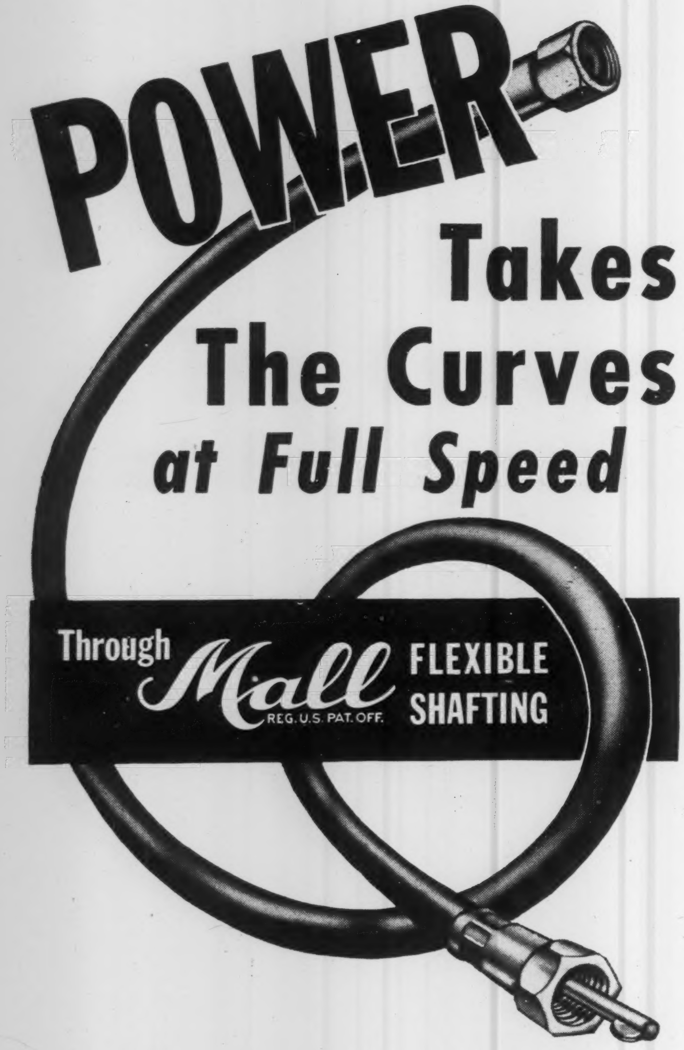


Howell Protected Type Motor

HOWELL MOTORS

HOWELL ELECTRIC MOTORS CO., HOWELL, MICH.

Manufacturers of Quality Industrial Type Motors Since 1915



The flexible characteristic of Mall Flexible Shafting eliminates many design problems and makes possible an almost unbelievable number of power drive and remote control applications.

Mall Flexible Shafting can be easily routed around curves, corners, through, under or over machinery, in walls, floors or ceilings with no loss in efficiency.

On power drive applications, it eliminates alignment worries by compensating for gears, chains, belts, pulleys, universal joints and similar drive mechanisms. On remote control applications, it eliminates the need for rods, cross shafts, and other rigid control devices. In addition, it enables the design engineer to build high efficiency, greater eye appeal, safety, and quieter operation into products with less weight and lower manufacturing costs.

Mall Flexible Shafting is available with Metallic or Plastic Covered Housings in any desired length or type with or without fitting for power transmission or remote control.

Our 25 years of designing, engineering and manufacturing experience assures correct design and high reliability in every Mall Flexible Shaft. Our Engineering Service is at your disposal. When writing give full details regarding installation. Engineering data mailed upon request.

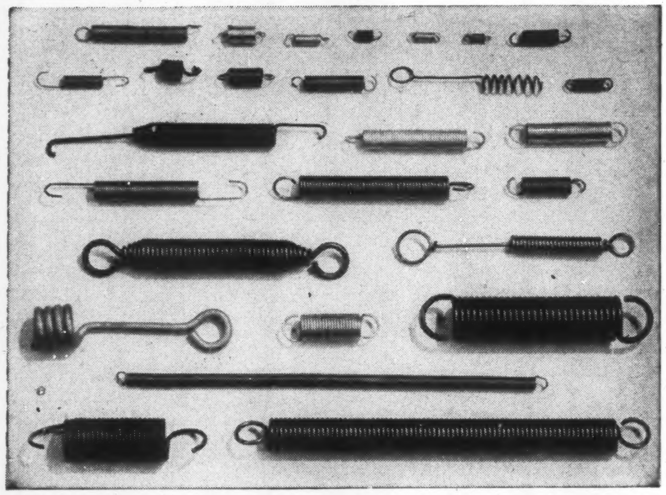
FLEXIBLE SHAFT DIVISION

MALL TOOL COMPANY

7731 South Chicago Ave., Chicago 19, Ill.

See Our Advertisement June 14th Issue The Saturday Evening Post

Mall REG. U.S. PAT. OFF. **PORTABLE POWER TOOLS**



for
Top-Grade SPRINGS
–You can Rely on
RELIABLE!

Reliable

Do you instruct your spring maker to use the utmost economy in producing your springs —so long as they pass your inspection? If so, you *may* be headed for trouble.

It is actually impossible for *any* spring user's inspection department, no matter how efficient, to prevent springs which have been "short-cut" in manufacturing from getting by. It is quite easy for any spring producer, especially if squeezed on price, to adopt those dangerous short-cuts which reduce costs *without* showing up in inspection, but which definitely affect the life and performance of the product in which the spring is used.

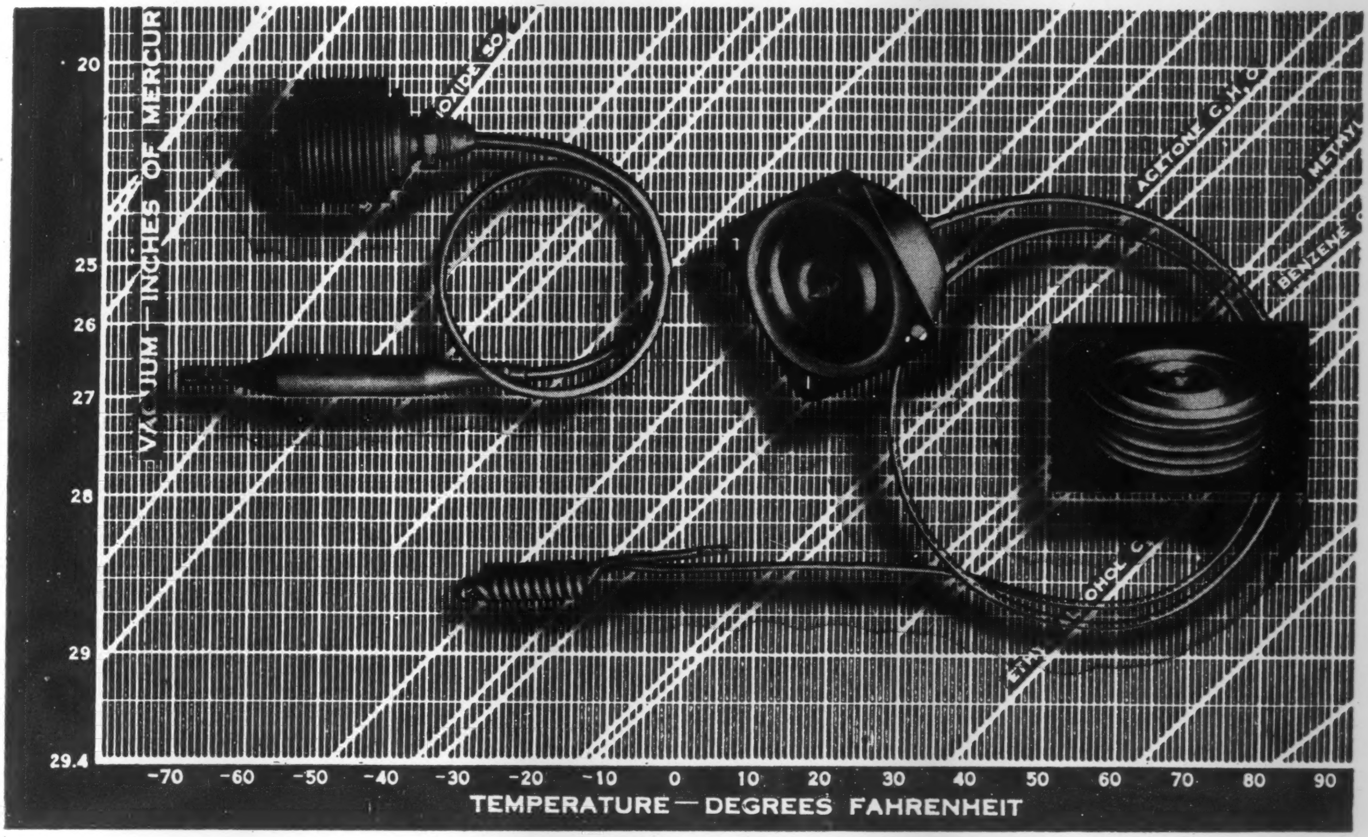
Therefore your best protection, as a spring user, still lies in the integrity of your spring maker for quality standards. Reliable will not be tempted to skimp or cut corners—we have too much at stake in reputation and good customer relations. You can *rely* on Reliable.

Additional 4-slide and other equipment now give us greater capacity than ever, and our inventories of most needed spring materials are good right now. Nor has Reliable increased prices by reason of present higher metal costs. Send us your specifications. Catalog on request.

The Reliable Spring & Wire Forms Co.
3167 Fulton Rd. Cleveland 9, Ohio

Representatives in Principal Cities

YOU CAN RELY ON
Reliable Springs
ROUND AND FLAT WIRE SPRINGS
CLIPS HOOKS BENDS
LIGHT STAMPINGS


VACUUM—INCHES OF MERCURY
20
25
26
27
28
29
29.4
-70 -60 -50 -40 -30 -20 -10 0 10 20 30 40 50 60 70 80 90
TEMPERATURE—DEGREES FAHRENHEIT
OXIDE SO
ACETONE C3H6O
METHYL
BENZENE C
ETHYL ALCOHOL C

ESSENTIAL FEATURES IN A BELLOWS ASSEMBLY

...and how Clifford engineering can help you get them

For the remote control of temperatures, a smoothly functioning bellows assembly engineered for the individual application is absolutely essential. The selection, application and handling of the thermosensitive filling medium are particularly critical, requiring an intimate knowledge of the medium's physical properties and chemical stability under all operating conditions.

HYDRON BELLOWS AND BELLOWS ASSEMBLIES

In addition to supplying HYDRON (Hydraulically-formed) bellows for many industrial purposes, Clifford specializes in producing bellows assemblies to individual specifications. Like the refrigerator assemblies illustrated, these are complete thermal units. Each unit is filled, sealed and tested, ready for installation.

COMPLETE HYDRON ASSEMBLIES PREFERRED

An increasing number of manufacturers are using these complete assemblies — preferring the undivided responsibility of an organization that has the engineering experience and equipment vital to this extremely technical work . . . If your own production involves remote or direct control of temperatures or pressures, Clifford engineering may save *you* time, trouble and expense. Send us prints and specifications and we will be glad to quote you.

CLIFFORD MANUFACTURING COMPANY, 566 E. First St., Boston 27, Mass. *Offices in Detroit, Chicago, Los Angeles.*

HYDRON Metal Bellows

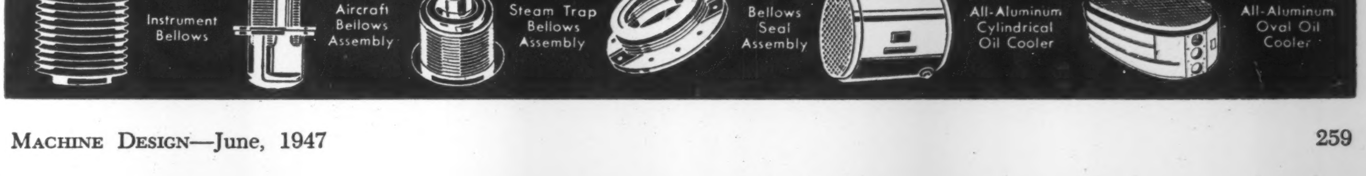
CLIFFORD

First with the Facts on Hydraulically-Formed Bellows

HYDRON

CLIFFORD Feather-Weight

Feather-Weight . . . The First All-Aluminum Aircraft Oil Coolers . . . Made of Hydron Tubing Brazed by our Patented Method.


Instrument Bellows
Aircraft Bellows Assembly
Steam Trap Bellows Assembly
Bellows Seal Assembly
All-Aluminum Cylindrical Oil Cooler
All-Aluminum Oval Oil Cooler

ARE YOU STILL AN ACTIVE PARTNER...

in this "7½ billion-a-year" success?

NEVER was there a partnership like the nation-wide brotherhood of volunteers who have helped sell, advertise, and promote sales of U. S. Savings Bonds! Their program is the greatest sales operation at the lowest cost in history.

Your continued support in promoting the Payroll Savings Plan will help "America's partnership" this year to repeat or surpass last year's four-star performance, in which sales of Savings Bonds were 7½ billion dollars—*exceeding redemptions by far more than a billion!*

So keep up the splendid work—keep on telling and selling your employees the advantages of Payroll Savings: (1) ease; (2) regularity; (3) safety of investment; (4) security for the individual and the nation; (5) $4 for every $3 at maturity! And, remember, people with a stake in the future are the most stable, most productive employees.

For any help you need in conducting the Plan, call on your State Director of the Treasury Department's Savings Bonds Division.

New Savings Bonds Plan won't affect the P.S.P.

THE Treasury Department and the banks of America are making it possible for farmers, doctors, and other self-employed people to participate in "automatic" Bond buying by special arrangement with their banks. This extension of the Savings Bonds program is not a partial payment plan and is intended *only* for people who are not in a position to take advantage of the Payroll Savings Plan.

The Treasury Department acknowledges with appreciation the publication of this message by

MACHINE DESIGN

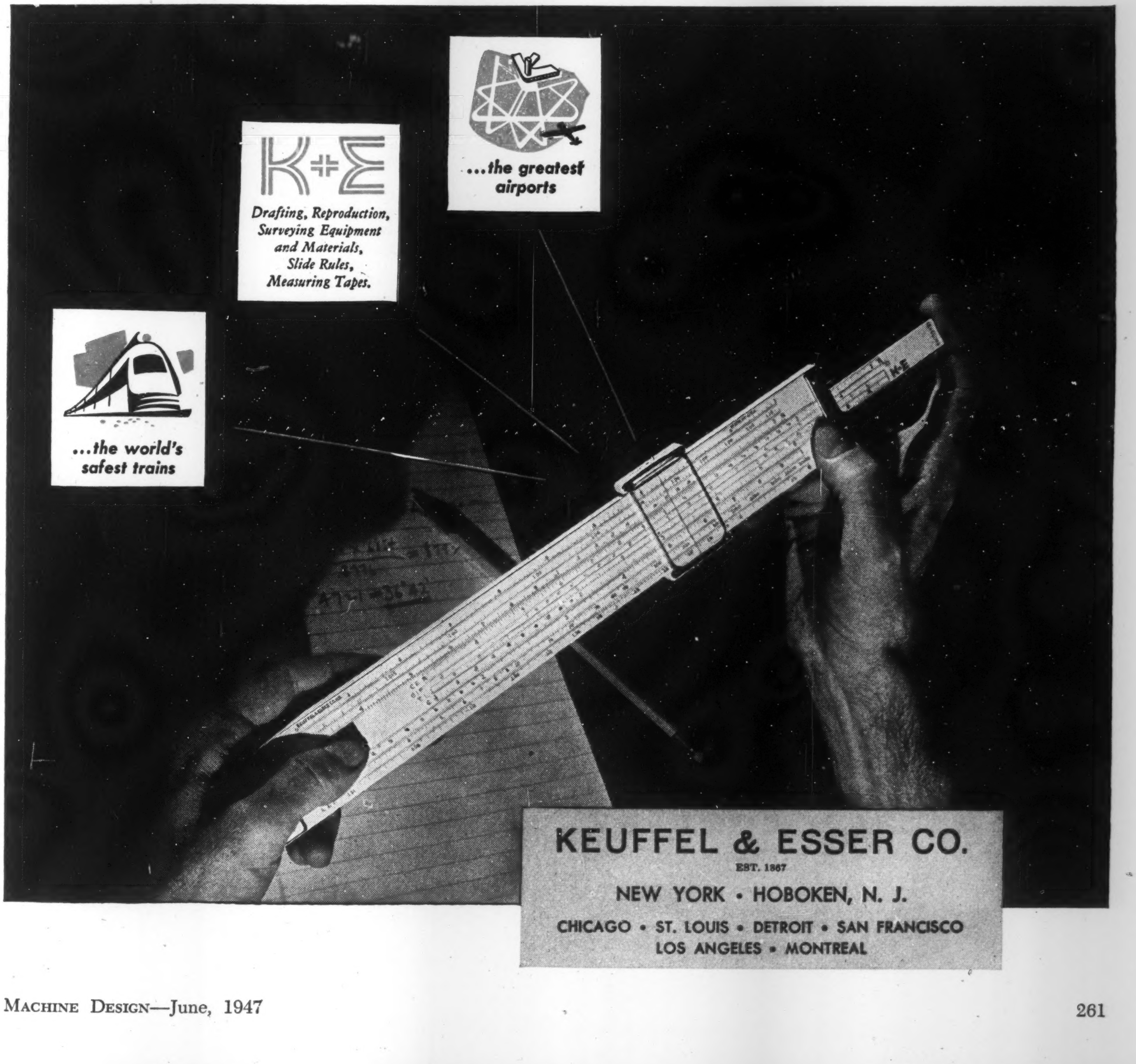
This is an official U.S. Treasury advertisement prepared under the auspices of the Treasury Department and The Advertising Council.

partners in creating

■ Many brilliant projects have been started with a K & E Slide Rule and the back of an old envelope. But between a new conception and its practical execution of the vital links are always the engineer and the draftsman. For through their techniques they construct the project on paper with unmistakable clarity and precision. In this their drafting instruments and equipment become part of their own hand and brain, and their partners in creating.

For 78 years Keuffel & Esser Co. Slide Rules, drafting equipment and materials have been partners in creating the greatness of America, in making possible our nationwide railway system, giant airports, fine radios for nearly every home . . . So universally is K & E equipment used, it is self-evident that every engineering project of any magnitude has been completed with the help of K & E. Could you wish any surer guidance than this in the selection of your own "engineering partners"?

In slide rules especially, you will find K & E precision invaluable. For it not only brings you a slide rule that is a joy to use, but it adds to your confidence in making every calculation. You will find Don Herold's booklet, "How To Choose A Slide Rule", amusing and very helpful. Write on your letterhead to Keuffel & Esser Co., Hoboken, N. J.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EST. 1867
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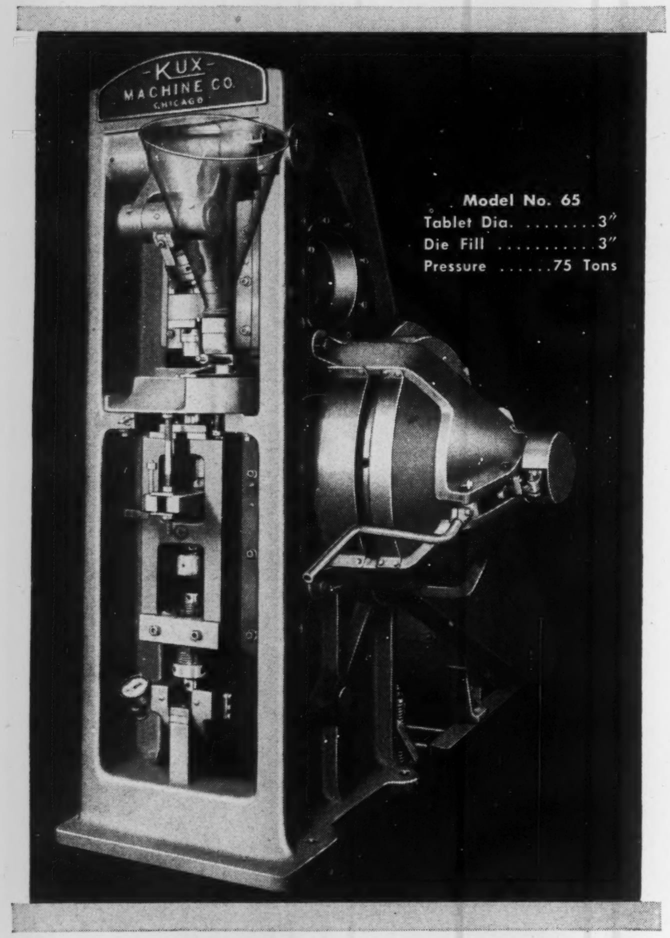
FIRST CHOICE

OF POWDER METALLURGISTS

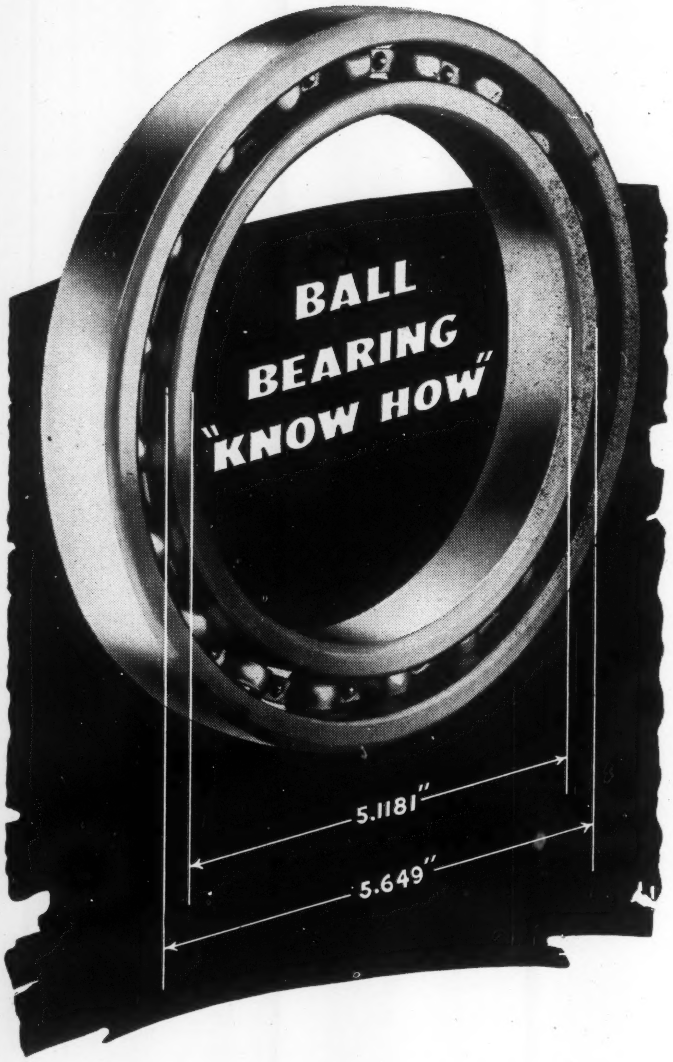
POWDER METALLURGY is the modern way of manufacturing many products because of the unbelievable cost savings produced from this automatic, high speed production method. On Kux Presses, porous, self-lubricating bearings, carbon brushes, and insulators, Alnico magnets, carbide tool bits, magnetic radio cores, contact buttons, gears, cams and literally thousands of other items are accurately and automatically made.

BUILDERS of the most complete line of machines for this industry, Kux Presses are selected by leading manufacturers for the superiority in design and construction built into every model. Send penny post card for detailed information and illustrated catalogue.



KUX MACHINE COMPANY

3928 WEST HARRISON STREET • CHICAGO 24, ILLINOIS

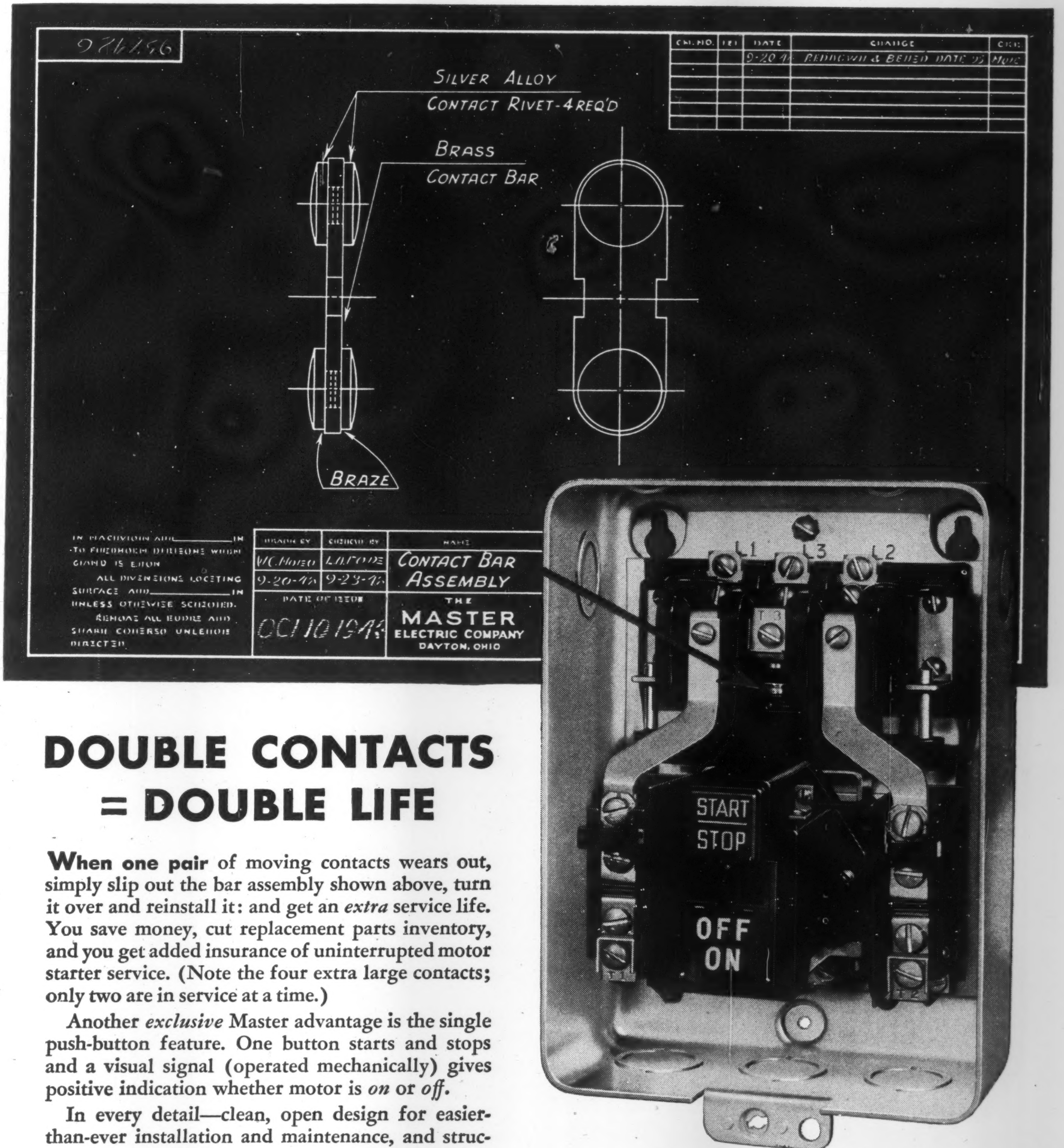


NOTE the exceptionally large diameter in relation to the race thickness of this radial ball bearing. It is not just an ordinary ball bearing —it's one that takes "ball bearing know how" to turn out to the exacting specifications of our customer. Tolerances allowed are close, for the piece of machinery into which this bearing goes is quality from end to end.

When you need **"BALL BEARING KNOW HOW"** *put it up to us.*

BEARINGS COMPANY OF AMERICA, LANCASTER, PA.

BCA RADIAL • ANGULAR CONTACT • THRUST **BALL BEARINGS**



SILVER ALLOY
CONTACT RIVET-4 REQ'D
BRASS
CONTACT BAR
BRAZE
DRAWN BY
CHECKED BY
NAME
CONTACT BAR ASSEMBLY
9-20-4
9-23-4
DATE OF ISSUE
OCT 10 194
THE MASTER ELECTRIC COMPANY DAYTON, OHIO
L1
L3
L2
T3
START
STOP
OFF
ON

Form A Starter with integral (Single) push button. Cover removed.

DOUBLE CONTACTS = DOUBLE LIFE

When one pair of moving contacts wears out, simply slip out the bar assembly shown above, turn it over and reinstall it: and get an *extra* service life. You save money, cut replacement parts inventory, and you get added insurance of uninterrupted motor starter service. (Note the four extra large contacts; only two are in service at a time.)

Another *exclusive* Master advantage is the single push-button feature. One button starts and stops and a visual signal (operated mechanically) gives positive indication whether motor is *on* or *off*.

In every detail—clean, open design for easier-than-ever installation and maintenance, and structural strength—Master starters give you extra advantages. Write for full details in Bulletin 200.

MASTER A.C. Across-the-Line Magnetic MOTOR STARTER

THE MASTER ELECTRIC CO. MASTER **DAYTON 1, OHIO**

This new starter bears a trademark long famous on motors, assuring product integrity in control equipment as well.

PICTURE QUIZ: Which of these five people gives the right reason for buying U.S. Bonds?

(ANSWER BELOW)

1. **Easy to save!** "I'm putting my money into U. S. Bonds because it's the *easiest way* for me to save. Under the Payroll Savings Plan, I put aside a regular amount each week for Bonds. So far, I've saved $500 without missing the money!"

2. **Good investment!** "Getting back $4 for every $3 I invest—the way I will in ten years' time with U. S. Bonds—is my idea of a *good investment.* I know it's safe and sound, too, because it's backed by Uncle Sam. Buy Bonds, I say."

3. **Plans for the future!** "Ten years from now, the money I'll get for my U.S. Bonds will help to send my kids to college, or buy our family a new home. I think that buying U. S. Bonds is the wisest thing a family man can do."

4. **Fights inflation!** "I want America to stay economically sound. That's why I'm putting all our extra dollars into U. S. Bonds. It's like buying a share in our country's future prosperity!"

5. **Rainy day!** "Maybe a rainy day's coming for me. Maybe it isn't. But I am taking no chances. That's why I'm buying all the U. S. Bonds I can through my Payroll Savings Plan."

THE ANSWER

Every one of these people gives the "right" reason—because there's more than one right reason for buying U. S. Bonds.

Whichever way you buy them—through Payroll Savings, or your local bank or post office—U.S. Bonds are the best investment you can make!

Save the easy way.. buy your bonds through payroll savings

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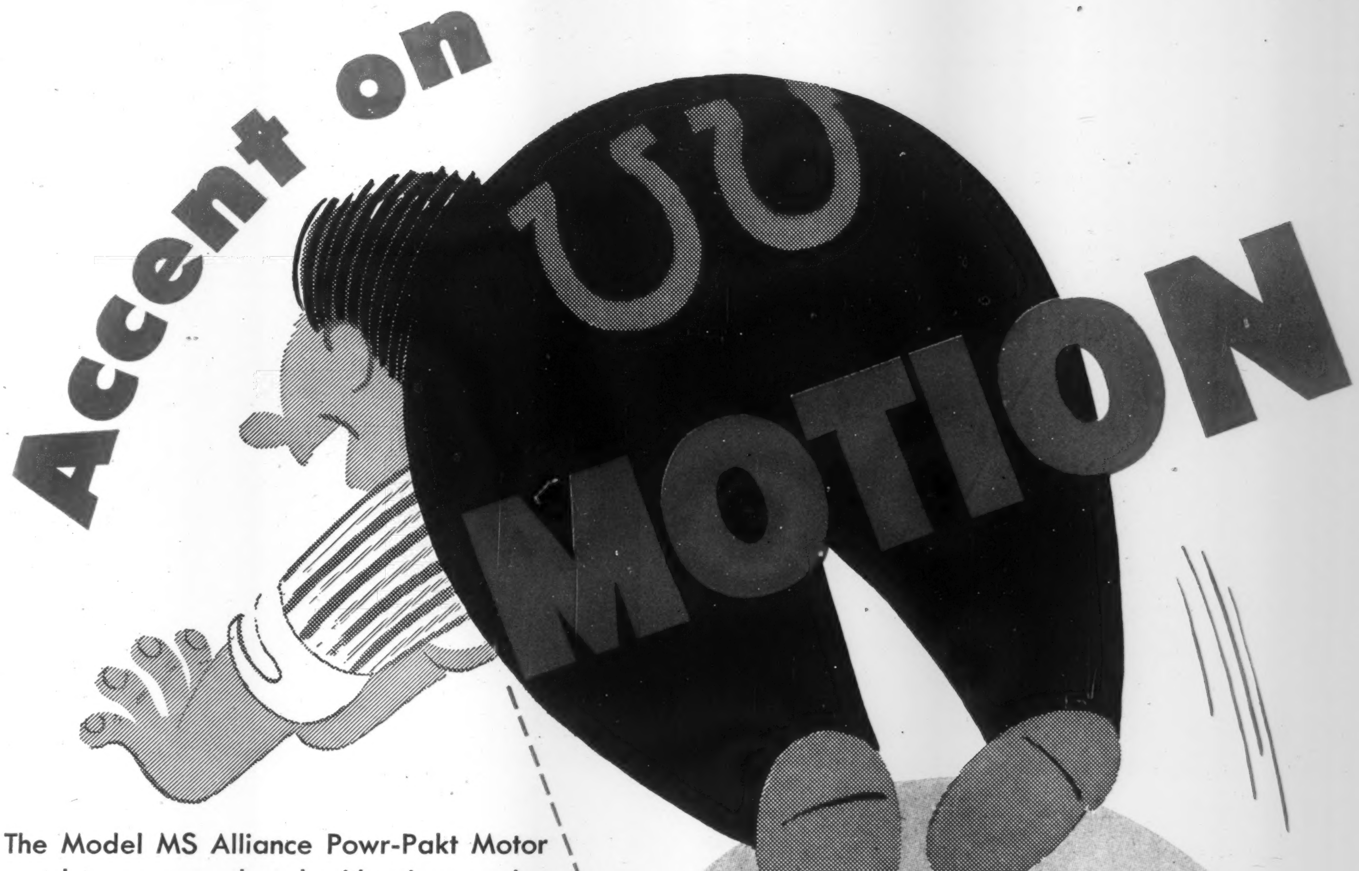
A Public Service Project
The Advertising Council



The Model MS Alliance Powr-Pakt Motor can be mass produced with minor variations to meet the demands of specific jobs which require a highly efficient miniature power plant. Operating over a wide range of AC voltages from 24 to 250 and frequency of 40, 50 or 60 cycles, this compact lightweight motor can be incorporated as the vital power source in all kinds of electrical and mechanical devices.

Here are just a few of the many applications which can use the Alliance Model MS or one of the other Powr-Pakt motors in the Alliance line:

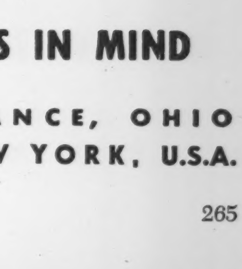
Electronic, electric, radio and time controls, radio tuning and turntable drives, valve and heating controls, coin operated mechanisms, signals, switches, business machines and other specialized uses.

The trend is to make things move!

Designs will call for more action — movement! Flexible product performance needs power sources which are compact, light weight! Alliance Powr-Pakt Motors rated from less than 1-400th on up to 1-20th h. p. will fit those "point-of-action" places! Alliance Motors are *mass produced at low cost* —engineered for small load jobs!

For vital component power links to actuate controls...to make things move . . . plan to use them!

Model MS Shaded Pole Induction Type Motor, size 3⅛"x 2"x 1¾". Weight, 1 lb. 2 oz.



WHEN YOU DESIGN—KEEP alliance MOTORS IN MIND

ALLIANCE MANUFACTURING COMPANY • ALLIANCE, OHIO
EXPORT DEPARTMENT; 401 BROADWAY, NEW YORK 13, NEW YORK, U.S.A.

short cuts for sale

To Meet Rush Schedules on assembly lines.

To Save You Steps in your manufacture of products, leave the parts production up to us.

The Specialist Can Do A Better Job For Less

U•S•AUTOMATIC
CORPORATION
Screw Machine Products
AMHERST • OHIO

IT IS PRECISION-MADE... AND THAT'S IMPORTANT

TRU•LAY
PUSH-PULL
Controls

Every Tru-Lay Push-Pull unit is engineered and made to transmit back-and-forth movement with practically no back-lash. This means that it can be used in many applications—either for remote control or as a working part of a machine—where the ordinary "choke control" could not be considered. Made in any length with input capacities ranging from 30 to 1000 pounds.

DETROIT, MICH.—TRU-LAY PUSH-PULL units are working successfully up to 150 feet in length. Others with the equivalent of ten 90-degree bends. Such extremes serve to illustrate their wide range of usefulness.

Machine designers are constantly finding new applications for TRU-LAY PUSH-PULL. They find that, by allowing more freedom in the placement of units or accessories, TRU-LAY PUSH-PULL is a real aid in machine design.

If you are not thoroughly familiar with the possibilities of TRU-LAY PUSH-PULL, let us send you a copy of our descriptive booklet on the subject. Then, if you wish more specific information, our engineers will be glad to consult with yours.

ACCO
6-235 General Motors Bldg., Detroit 2
695 Bryant Street, San Francisco 7 • Bridgeport, Conn.

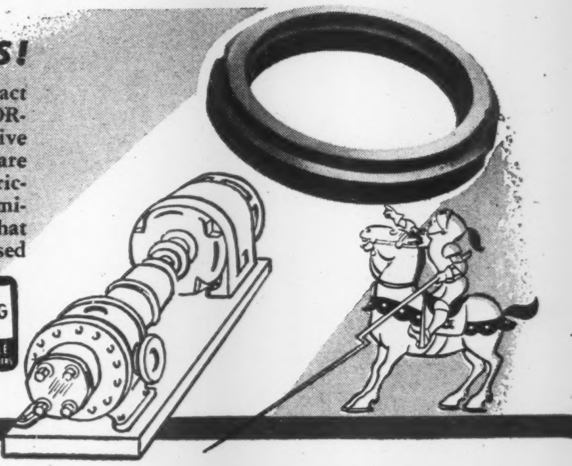
AUTOMOTIVE AND AIRCRAFT DIVISION
AMERICAN CHAIN & CABLE

TRADE MARK
In Business for Your Safety

INCREASING ACCEPTANCE WHERE ACCEPTANCE COUNTS!

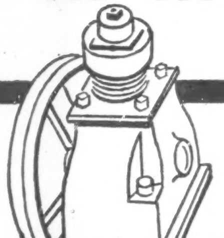
Best proof of MORGANITE Seal Rings efficiency is the fact that year after year *more* seal manufacturers use *more* MORGANITE rings than ever before. The features that give MORGANITE Seal Rings top rating with manufacturers are inherent in their carbon graphite composition—minimum friction, self-lubrication, stability in presence of moisture, chemically inert and non-contaminating. Another is the fact that MORGANITE rings can be molded in most shapes used in present design—with exact uniformity—at relatively low cost. These points of superiority, plus many others equally important, are completely described in literature available on request, and in Sweet's File of Product Designers.

see our CATALOG in SWEET'S FILE for PRODUCT DESIGNERS



MORGANITE SEAL RINGS

are standard equipment in most seal assemblies



AN INTEGRAL PART OF MANY CRANE COMPANY PACKING SEALS!

Crane seals are recognized by product designers everywhere as first line equipment for tough shaft-sealing jobs of every description. For this reason it is significant that MORGANITE Seal Rings are an integral part of many Crane seals . . . that they are relied upon by most "big name" manufacturers to provide a perfect sealing surface that cannot corrode, warp or gum under the severest service conditions. Call or write for full information.

Morganite INCORPORATED

REGISTERED TRADE MARK

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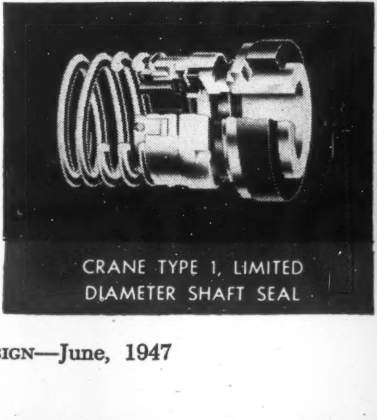


CRANE TYPE 1, LIMITED DIAMETER SHAFT SEAL

CARBON GRAPHITE SEAL RING INDICATED IN WHITE

CRANE TYPE 2, LIMITED LENGTH SHAFT SEAL

Solving
Speed-Control
Problems
is work for specialists

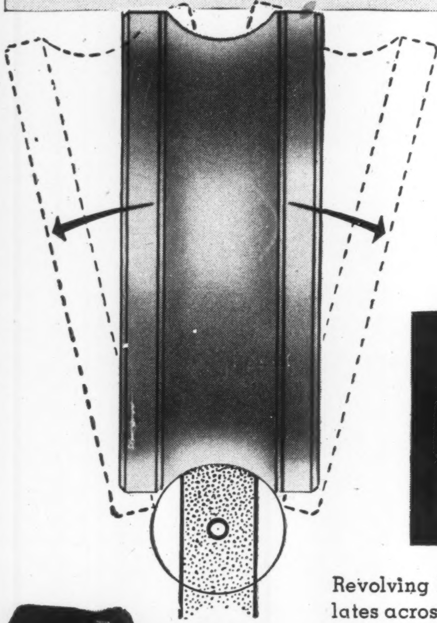
**When you
look to Lewellen
you employ
the pioneer*
in speed-control**

*Speed Control exclusively
for more than 45 years

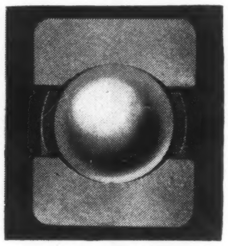
**Wire, phone or write
LEWELLEN MFG. CO.
Columbus, Indiana**

LEWELLEN
Variable-Speed
TRANSMISSIONS—MOTOR PULLEYS

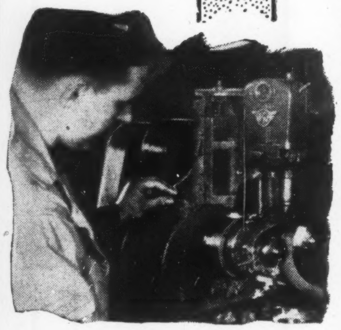
GENERATED RACEWAYS
for
TRUE RACE CURVATURE
*MAXIMUM BEARING CAPACITY,
MAXIMUM LIFE*



CJB Ahlberg Ball Bearing Raceways are "generated" to true geometric curvature.



Revolving bearing ring oscillates across the face of a high speed grinding wheel, resulting in a "generated" raceway—a perfect seat for the balls.

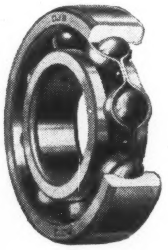


★Highlights on CJB Ahlberg Ball Bearings:

- Accurate fit for balls to raceways—for greater capacity.
- Raceways lapped and polished to mirror smooth surfaces—for quiet performance . . .
- Races and balls of chrome alloy electric furnace steel—hardened throughout—for strength and durability . . .
- Deep groove bearings have heavy race section—for minimum distortion and higher thrust capacity . . .

★. . . add up to quiet operation—ample capacity—long life.

Ahlberg Bearing Company, 3017 W. 47th Street, Chicago 32, Illinois.



Ahlberg *Bearings* CHICAGO

BALL BEARINGS • ROLLER BEARINGS • PILLOW BLOCKS

I look for all 8 to get t.f.e.

True Fastener Economy

It is the many costs of using a fastener that count . . . not just the initial price. T*rue* F*astener* E*conomy* is the lowest *total* cost for fastener selection, purchase, assembly and performance.

YOU GET t.f.e. WHEN YOU . . .

1. Reduce assembly time to a minimum by savings through use of accurate and uniform fasteners

2. Make your men happier by giving them fasteners that make their work easier

3. Reduce need for thorough plant inspection, due to confidence in supplier's quality control

4. Reduce the number and size of fasteners by proper design

5. Purchase maximum holding power per dollar of initial cost, by specifying correct type and size of fasteners

6. Simplify inventories by standardizing on fewer types and sizes of fasteners

7. Save purchasing time by buying larger quantities from one supplier's complete line

8. Contribute to sales value of final product by using fasteners with a reputation for dependability and finish

RUSSELL, BURDSALL & WARD BOLT AND NUT COMPANY

102 years making strong
the things that make America strong

RB&W
BOLTS, NUTS, SCREWS,
RIVETS and ALLIED
FASTENING PRODUCTS

Plants at Port Chester, N. Y., Coraopolis, Pa., Rock Falls, Ill., Los Angeles, Calif. Additional sales offices at Philadelphia, Detroit, Chicago, Chattanooga, Portland, Seattle. Distributors from coast to coast. By ordering through your distributor, you can get prompt service for your normal needs from his stocks. *Also*—the industry's most complete, easiest-to-use catalog.

ORDER YOUR COPY NOW...

MECHANICAL SPRINGS

by A. M. Wahl

. . . eminent authority on springs and well-known for his development of the "WAHL CORRECTION FACTOR." He speaks from a wealth of practical experience obtained through his association with the Westinghouse Electric and Manufacturing Company

$6.00* POSTPAID

BASED on original research and on practical applications, "Mechanical Springs" also includes results of investigations carried out under the direction of the American Society of Mechanical Engineers and the War Engineering Board Spring Committee of the Society of Automotive Engineers.

Fundamental principles and recent developments are presented so that springs can be designed to perform more satisfactorily than if "rule of thumb" methods were employed—saving both time and materials. Being important components of modern machines and devices, springs should be designed with care, especially if fatigue or repeated loading is involved. The information covered puts design on a rational basis. Convenient charts and tables aid quick selection. A glance at the contents will convince you of the comprehensive scope of this book.

CONTENTS

General Considerations in Spring Design—Helical Round-Wire Compression and Tension Springs—Open-Coiled Helical Springs with Large Deflection—Static and Fatigue Tests on Helical Springs and Spring Materials—Helical Springs Under Static Loading—Fatigue or Variable Loading of Helical Springs—Practical Selection and Design of Helical Compression Springs—Buckling of Helical Compression Springs—Helical Springs for Maximum Space Efficiency—Tension Springs—Square and Rectangular-Wire Compression Springs—Vibration and Surging of Helical Springs—Initially-Coned Disk (Belleville) Springs—Initially-Flat Disk Springs—Flat and Leaf Springs—Helical Torsion Springs—Spiral Springs—Ring Springs—Volute Springs—Rubber Springs and Mountings—Energy-Storage Capacity of Various Springs—Spring Materials.

TEN DAYS FREE EXAMINATION

If for any reason "Mechanical Springs" is not exactly what you need, it may be returned within ten days after receipt.

MACHINE DESIGN

Book Department

Penton Building Cleveland 13, Ohio

* Orders for delivery in Ohio, 18c additional for state sales tax. Postage will be prepaid if payment accompanies order, otherwise postal charges will be added.

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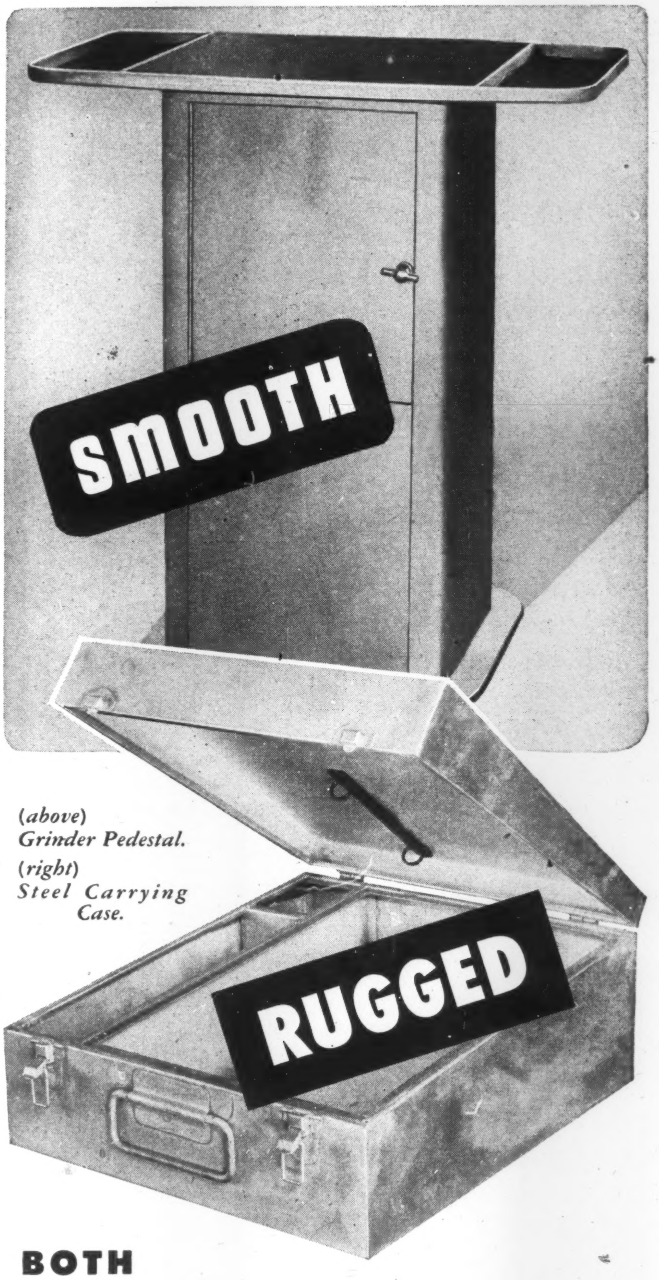

(above)
Grinder Pedestal.
(right)
Steel Carrying Case.

BOTH

Quality AND *Economy*

IN SHEET METAL FABRICATING

Here's how we *actually* do it: Your *finest* sheet metal units result from infinitely precise workmanship, using up-to-the-minute fabricating methods and equipment. *Costs* tumble with combined production efficiency and economy. When current procurement problems ease, call on us for service patterned exactly to your needs.

MANUFACTURERS
Special Steel Equipment
Metal Cases—Cabinets
CONTRACTORS
Sheet Metal
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RIESTER & THESMACHER
COMPANY
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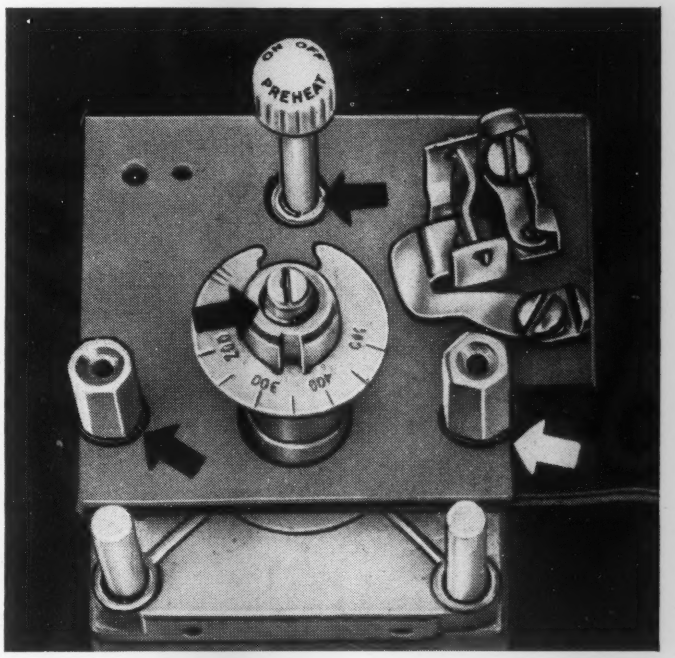
RETAINING RINGS

Simplify and Save



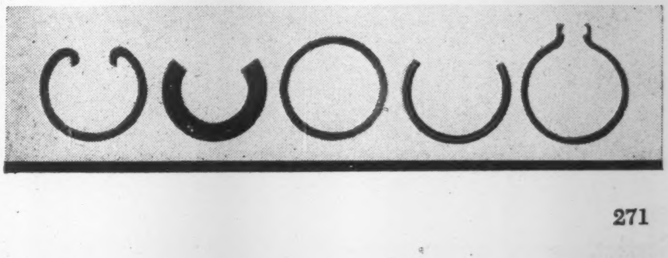
On these beautifully designed Wilcolater Thermostats our retaining rings are "naturals" for simplification and economy. On such highly efficient products, every part is designed for compact reliable service.

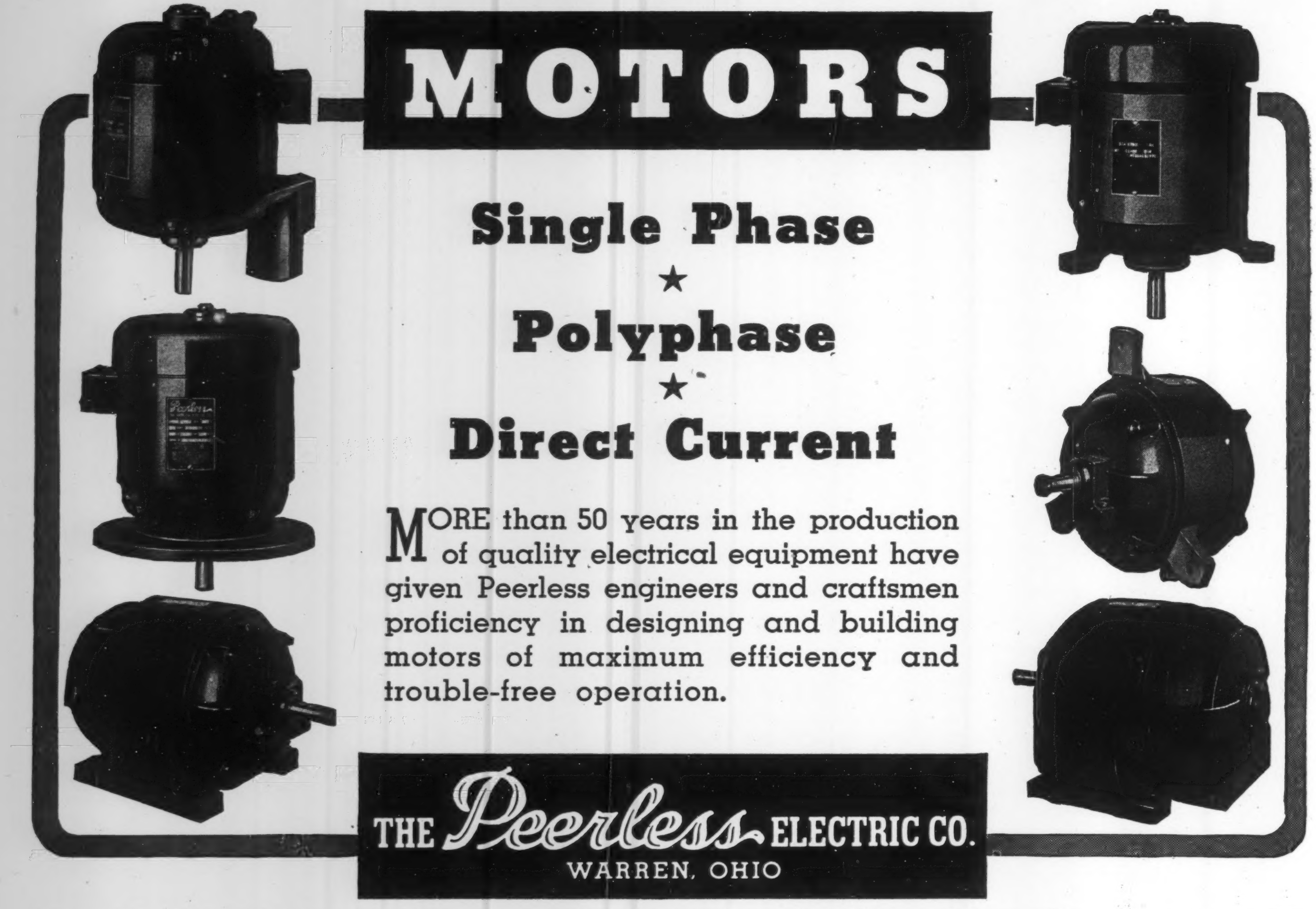
And on hundreds of other products and machines these effective yet inexpensive artificial shoulders are saving money and material – eliminating the need of extra parts, cutting down assembly costs.

Don't cut down shafts to make shoulders —*groove* your shafts and housings, and use steel retaining rings.

Write today for our retaining ring folders.

THE NATIONAL LOCK WASHER COMPANY
NEWARK 5, N. J. MILWAUKEE 2, WISCONSIN





MOTORS

Single Phase
★
Polyphase
★
Direct Current

MORE than 50 years in the production of quality electrical equipment have given Peerless engineers and craftsmen proficiency in designing and building motors of maximum efficiency and trouble-free operation.

THE *Peerless* ELECTRIC CO.
WARREN, OHIO

Are You Offering

"Production Count"

with the Machines you design and build?

The more complete a machine is, the more it pleases your customers, and an added feature bound to increase acceptability and permanent satisfaction is a

PRODUCTIMETER COUNTING UNIT

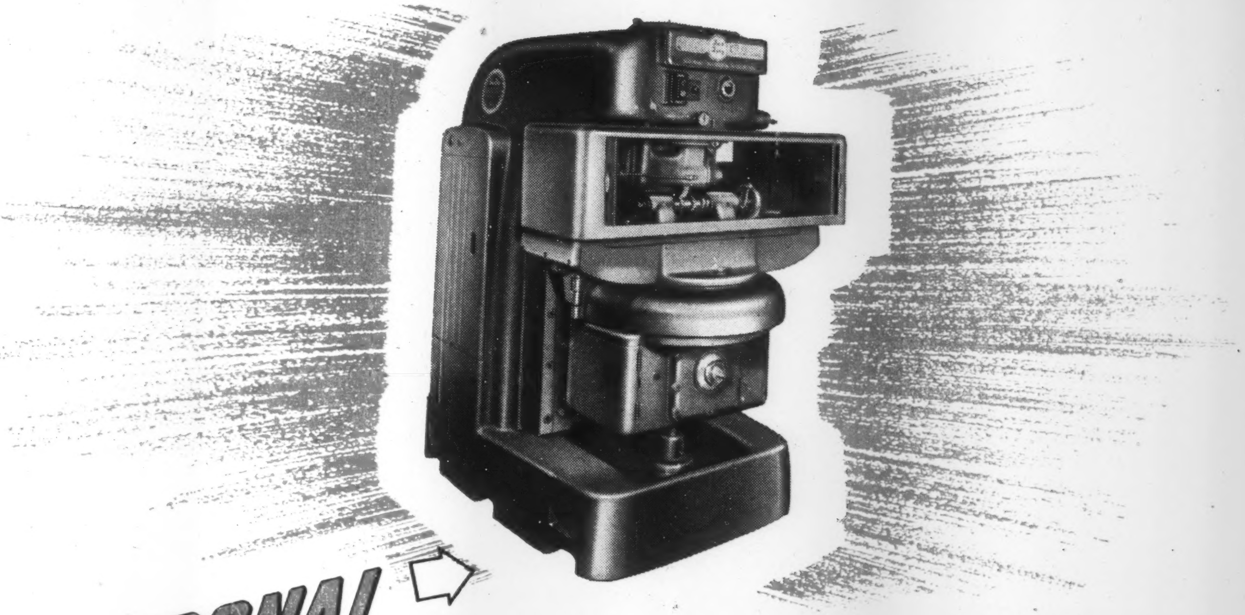
Its installation gives plus-value to your machines: an accurate count for production control . . . time study . . . costs and planning schedules.

You can depend upon Productimeters because of their rugged construction and accurate performance for many years of service. A wide range of sizes and speeds to select from.

NEW design of double deck Model "N" units, as illustrated, offer smooth action and high speeds . . . to register short runs and weekly totals. Rear drive rotary, regular, and end drive Predetermined counters shown.

Just off the press . . . General Catalog . . . attractively printed in colors . . . contains complete specifications. Send for your copy!

DURANT MANUFACTURING COMPANY
1933 NORTH BUFFUM STREET • MILWAUKEE 1, WISCONSIN



A DIAGONAL GEAR SHAVING MACHINE FOR HIGH PRODUCTION

The new Red Ring Model GCU Diagonal Shaving Machine has been developed especially for mass production. While the principle of Rotary Crossed Axes shaving which has proved itself over the years is retained, an entirely new method of its application provides a number of advantages in production operations. Some of these are:

1. Greater stock removal on each cutting stroke.
2. Reduced time for each cutting cycle.
3. Complete cutting cycle just two passes under cutter.
4. Cutter life materially extended.
5. Cutter cost greatly reduced in many cases.
6. No special cutters required.
7. Better control of lead angle on helicals.
8. Operator fatigue reduced.
9. Oversize gears automatically screened out.
10. Operator's haste cannot jeopardize tooth surfaces.
11. Amount of crown on Elliptiod teeth can be varied.

For full details write for bulletin.

2523

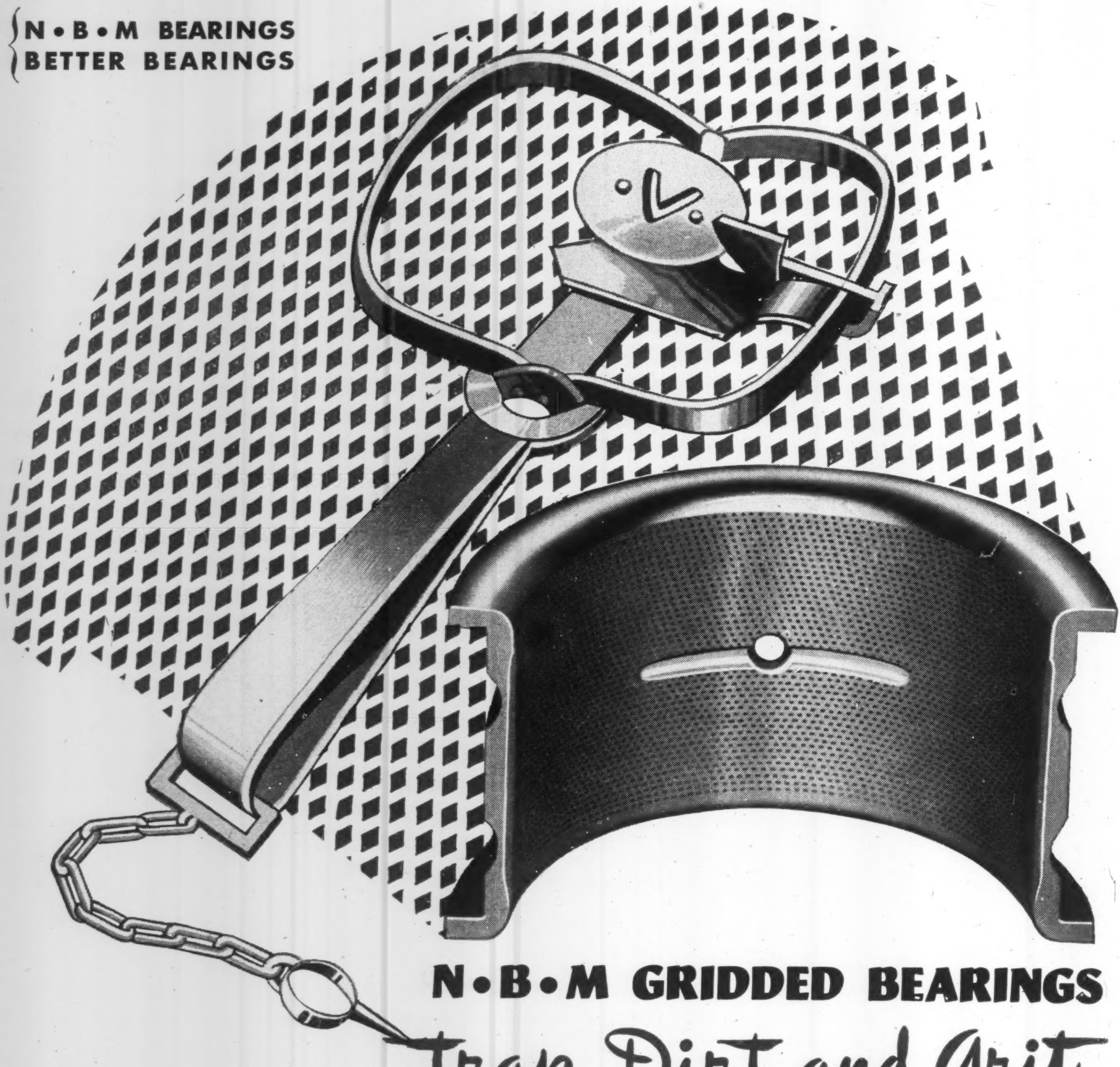
RED RING PRODUCTS

NATIONAL BROACH AND MACHINE CO.

5600 ST. JEAN • DETROIT 13, MICHIGAN

SPECIALISTS ON SPUR AND HELICAL INVOLUTE GEAR PRACTICE • ORIGINATORS OF ROTARY SHAVING AND ELLIPTOID TOOTH FORMS

N • B • M BEARINGS
BETTER BEARINGS



N • B • M GRIDDED BEARINGS
trap Dirt and Grit

These shaft-protecting bearings are equipped with thousands of grids filled with N-B-M Silver Babbitt. Destructive dirt and grit are caught in these tiny "traps" and safely embedded below the surface without affecting bearing performance.

Due to our new manufacturing processes, centrifugally-cast N-B-M gridded bearings are now available at "mass-production" savings. May we send you complete engineering data?

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HELPFUL LITERATURE

FOR DESIGN EXECUTIVES

59. Hydraulic Pumps

Adel Precision Products Corp.—8-page illustrated bulletin on series K pumps gives design, performance and application data on this fluid metering type hydraulic pump which is light in weight, is driven by 24-volt universal motor and is available in capacities from 2.5 to 30 gallons per hour.

60. Injection Plastic Molding

Tennessee Eastman Corp.—36-page illustrated guidebook entitled "Tenite Injection Molding" deals with all aspects of the plastic injection molding process: choice of material of right flow and hardness, preparation of material for molding, proper design of part to be molded, injection molding machines, mold design and construction, and various methods of finishing. Cross-section drawings show operations, typical mold designs and other phases.

61. Recessed Head Screws

Reed & Prince Mfg. Co.—32-page illustrated booklet "Recessed Heads" discusses advantages of using recessed head screws and bolts. List prices and other data are given on recessed head flat, round, oval, stove and binding head hardened sheet metal screws; flat, round, oval and fillister head machine screws and stove bolts. Details of hand screwdrivers and power bits for recessed head screws are given.

62. Shaft Seals

Sealol Corp.—6-page illustrated bulletin No. 4 presents complete specifications on Sealol series 30,000 and 40,000 balanced pressure seals which are of rotary type. Information is given also on model CB mechanical seals for rotating shafts on pumps, motors, gear boxes, compressors, etc.

63. Over-running Clutch

Hilliard Corp. — 6-page illustrated bulletin No. 231 lists construction and operating features of available types of over-running clutch and coupling units which allow driven member of machine to "over run" the drive member. Dimensions, capacities and application data are listed.

64. Flexible Shafting

Walker Turner Co.—20-page illustrated engineering data bulletin covers construction, characteristics, selection and application of Walker-Turner flexible shafting. Torque and dimensional information are tabulated on shafting, housings and tubing. Engineering information is given to aid in selection of proper unit for aircraft, radio, appliance, machinery and other uses.

65. Fastening Devices

John Hassall, Inc.—48-page illustrated catalog No. 50 is descriptive of cold forged specialties, special nails, special points and heads, copper nails, escutcheon pins, special rivets, annular threaded screws, drive screws, fluted and knurled fasteners, machine screws and products requiring secondary operations. Engineering data and charts related to these parts are included. Special nails, rivets and screws are produced in wide range of ferrous and nonferrous metals and alloys.

66. Rubber Parts

H. O. Canfield Co.—104-page technical catalog and 16-page general catalog of "Rubber and Synthetic Rubber Products" illustrates and describes extensive line of rubber products and component parts for which mold and die equipment is available. Parts available include grommets, gaskets, automotive and aviation parts, electrical and appliance parts, bumpers, rings, bushings, hose, extruded parts, etc.

67. Machines, Tools & Fixtures

Bunell Machine & Tool Co.—4-page illustrated folder is entitled "Products Designed and Built from Your Blueprint". It discusses facilities for production of special machines, tools, dies, jigs, fixtures and gages in numerous types.

68. Reproduction Equipment

C. F. Pease Co.—238-page illustrated catalog, tenth edition, describes line of blueprinting machines and accessories, whiteprinting machines, sensitized papers and cloths, drafting room furniture and photographic arc lamps.

69. Timing Motors

R. W. Cramer Co.—4-page illustrated bulletin No. 10 gives design and application data on new type SX self-starting synchronous timing motors. Output speed ranges of 1-revolution per day to 60 revolutions per minute can be obtained by use of available gear trains.

70. Self-Lubricating Bearings

Nolu Oilless Bearing Co.—6-page illustrated folder "Nolu Self-Lubricating Machinery Bearings" gives design, application and other information on these oil-impregnated tooled hardwood bearings for use in all types of machines and equipment.

71. Hydraulic Accumulators

Greer Hydraulics, Inc. — 8-page illustrated bulletin "Accumulators for Industry" describes available types of these units which store hydraulic power for instant use and absorb pressure impulses for smooth, surgefree operation.

72. Laminated Materials

Haskelite Mfg. Corp.—8-page illustrated bulletin "Haskelite" deals with versatile structural materials which combine wood, metal and plastics. Comparative stiffness of various types, suggested uses and properties of each of these laminated materials are given.

73. Threaded Parts

Cleveland Cap Screw Co.—4-page illustrated bulletin "This Is the Kaufman Process" describes cold-forging method which assures production of strong threaded fasteners. Details of process, typical threaded parts produced and advantages are outlined.

74. Air Control Valves

Numatics—Seven illustrated 2-page bulletins Nos. 1010, 1020, 1021, 1030, 1034, 1035 and 1036 describe three and four-way hand operated and solenoid valves for compressed air control applications.

75. Fluid Motors

Dudco Products Co.—4-page illustrated folder and five data sheets describe vane-type fluid motors. Principles of design and operation, specifications, dimensional drawings, performance curves and tables of characteristics are included.

FOR MORE INFORMATION

on developments in "New Parts" and "Engineering Department" sections—or if "Helpful Literature" is desired—circle corresponding numbers on either card below.

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76. Self-Lubricating Bearings

Chrysler Corp., Amplex Div.—8-page illustrated bulletin "Oilite Oil Cushion Bearings and Machine Parts" tabulates features of Oilite bronze and iron powder metal oil-impregnated materials, shows typical bearings and parts available, and suggests applications.

77. Investment Casting

Kerr Dental Mfg. Co.—12-page illustrated bulletin "Fundamentals of Industrial Precision Casting" discusses basic process, dies, lubrication, wax and wax characteristics, procedure and other phases of this "lost wax" method of producing precision castings.

78. Large Forged Nuts

Jos. Dyson & Sons, Inc.—6-page illustrated brochure "There is No Substitute for Quality" describes facilities for manufacturing large forged nuts starting at 3 inches in size in any thread and finish. Examples are shown also of flat die forgings weighing from 10 to 14,000 pounds and hydraulic pressed forgings.

79. V-Belt Drives

Allis-Chalmers Mfg. Co.—12-page illustrated bulletin No. B6051E contains condensed data on Magic-Grip sheaves, Vari-pitch sheaves and Texrope V-belt drives to aid in selection and application of correct drives for wide range of purposes. List prices, stock sizes, dimensions and construction details are given.

80. Wire Cloth

C. O. Jelliff Mfg. Corp.—96-page engineering data book and price list on industrial wire cloth deals with list prices, dimensions of open areas, weights and wire sizes of wire cloth which can be produced from aluminum, brass, copper, phosphor bronze, Monel, nickel, nickel-chromium, stainless steel and Inconel.

81. Sheet Metal Products

Riester & Thesmacher Co. — 4-page illustrated folder shows plant equipment and examples of typical sheet metal products that can be made to order. Engineering service and production and assembly facilities are covered.

82. Hydraulic Equipment

Power Plus Products Co.—63-page illustrated catalog on line of hydraulic cylinders for oil operation and hydraulic power units includes detailed drawing and engineering data on each model. Capacities of hydraulic rams in tons are charted. Gage pulsator is shown and described briefly.

83. Aluminum

Aluminum Co. of America—96-page illustrated spiral-bound handbook entitled "Alcoa Aluminum in Automatic Screw Machines" is instructional and technical book. Recommended and approved practices for using aluminum in screw machines are covered and tables of technical data are included.

84. Condensing Units

Jack & Heintz Precision Industries, Inc.—6-page illustrated bulletin No. SF-5002 describes condensing units utilizing heavy duty capacitor motors, positive displacement, vertical reciprocating, single acting type compressors; and air-cooled condensers. Specifications and capacity data are given.

85. Selector Valve

Pesco Products Co.—2-page illustrated bulletin No. 106 presents information on model No. 051008-020 selector valve. Features of unit capable of handling up to 5 gallons of liquid per minute in any type hydraulic system are outlined.

86. Reverse Switches

Euclid Electric & Mfg. Co.—2-page illustrated bulletin No. 1002A presents information on handle operated and pendant mounted thumb operated reverse switches which are suited to many light duty applications on machine tools, small hoists and similar equipment.

87. Gasoline Engine

Crosley Motors, Inc.—4-page illustrated bulletin lists design, construction and other features of the new Crosley copper-brazed Cobra gasoline engine. This 4-cylinder engine develops 26.5 horsepower at 5200 revolutions per minute and weighs 120.9 pounds without radiator.

88. Temperature Recorder

General Electric Co.—8-page illustrated bulletin No. GEA-4572 describes type CF-2 inkless temperature recorder for use in checking temperatures in generators, transformers, ovens, air ducts, etc. Accessories for use with this instrument are described also.

89. Automatic Clutch

Salsbury Motors, Inc.—4-page illustrated bulletin No. 4501 contains information on models 600 and 300 automatic clutches employing automatic centrifugal action for fluid drive performance, plus positive engagement and disengagement. Numerous uses to which automatic clutch can be applied are suggested.

90. Hole Punching Units

Wales-Strippit Corp. — 16-page illustrated catalog No. CD describes type CD hole punching units and mounting methods which reduce press down-time. Mild sheet metal up to ⅛-inch thick can be handled. Time and money saving advantages of system are described and prices are given.

91. Lubricating System

Trabon Engineering Corp.—6-page illustrated bulletin No. 423 describes reversing lubricating system applicable to all types of machinery and equipment requiring positive lubrication with oil or grease. Operation, features and schematic diagram of typical installation are covered.

92. Motorized Hydraulic Drive

Link-Belt Co.—16-page illustrated book No. 2085 presents data regarding Electrofluid drive which is packaged power unit that permits use of motor of size suitable for normal power requirements. Starting loads are readily handled because of fluid coupling.

93. Steel Plate Shapes

By-Products Steel Corp.—12-page illustrated bulletin describes services offered by this company in the production of flame-cut, sheared, pressed, bent, blanked and welded steel plate shapes. Typical components and partially fabricated units are shown.

94. Shut-Off Coupling

Hansen Mfg. Co.—2-page illustrated sheet, form No. 1001, presents application data and features of series 8000 two-way shut-off coupling for use on hydraulic and pneumatic lines.

95. Pressure Analyzer

Aeroquip Corp.—4-page illustrated bulletin No. 109 describes uses and method of operation of Hydrauliscope and gives technical data relative to this high speed portable electronic analyzer for determining characteristics of hydraulic pressure phenomena. Unit utilizes cathode ray tube for observation.

96. Drawing Instrument

Pomeroy Stereograph Co.—5-page illustrated folder form No. PS-47 describes perspective drawing instrument, shows typical examples of work and points out savings that can be effected by its use.

97. Castings

Advance Foundry Co. — 8-page illustrated booklet presents information on typical Strenes metal castings made for dies having wide range of uses and for machine parts. Advantages of metal for different kinds of casting requirements are outlined.

98. Time-Count Relays

Eagle Signal Corp.—12-page illustrated bulletin No. 291 presents information about Eagle time-count relays to control opening and closing of electrical circuits by time and impulse. Typical applications, specifications and schematic wiring diagrams are given.

99. Hydraulic Oil Purifiers

Honan-Crane Corp.—4-page illustrated bulletin describes hydraulic oil purifiers for use with presses, machine tools, die casting and plastic molding presses and machines, balers, injection molding machines and others.

100. Check Valve

Mansfield & Green—Illustrated data sheet presents size, working pressure and price data on six types of Twin Seal check valves for handling water, air, oil, gas and other materials.

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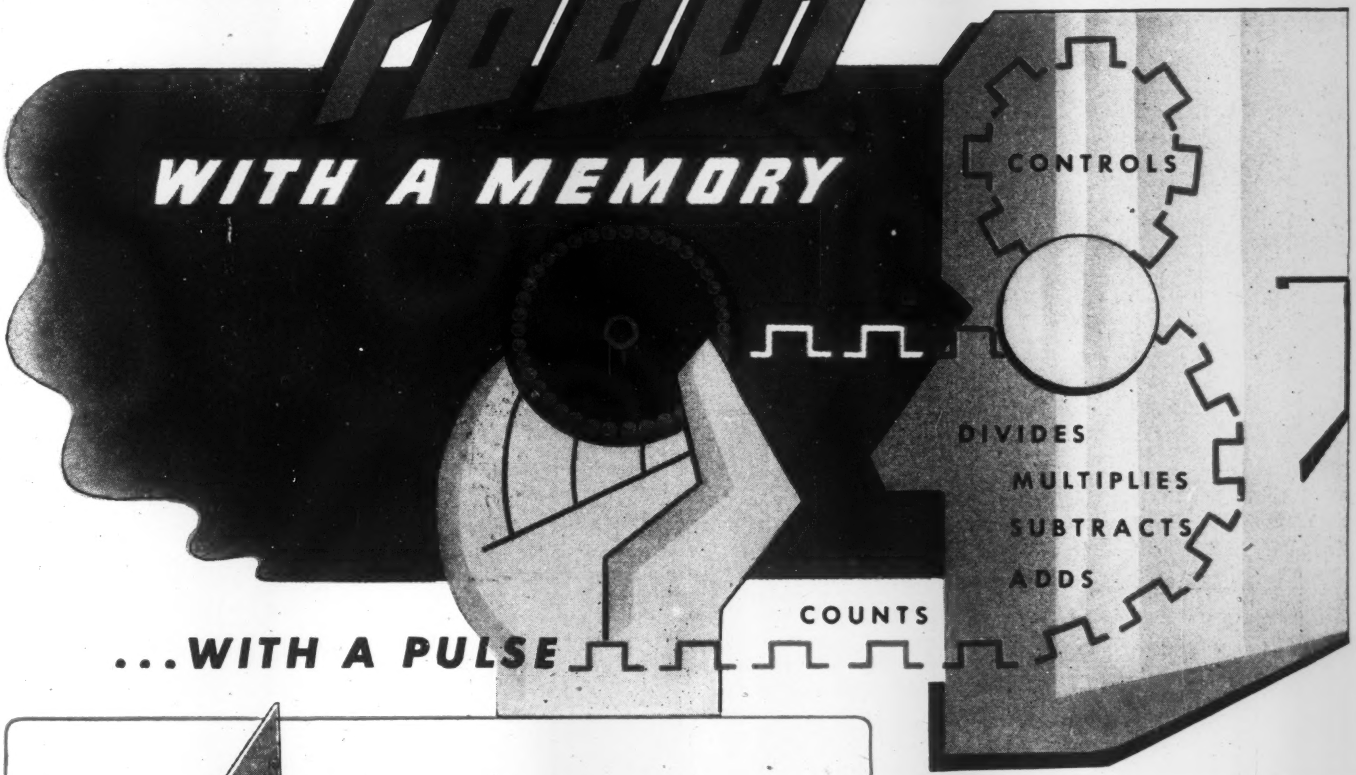
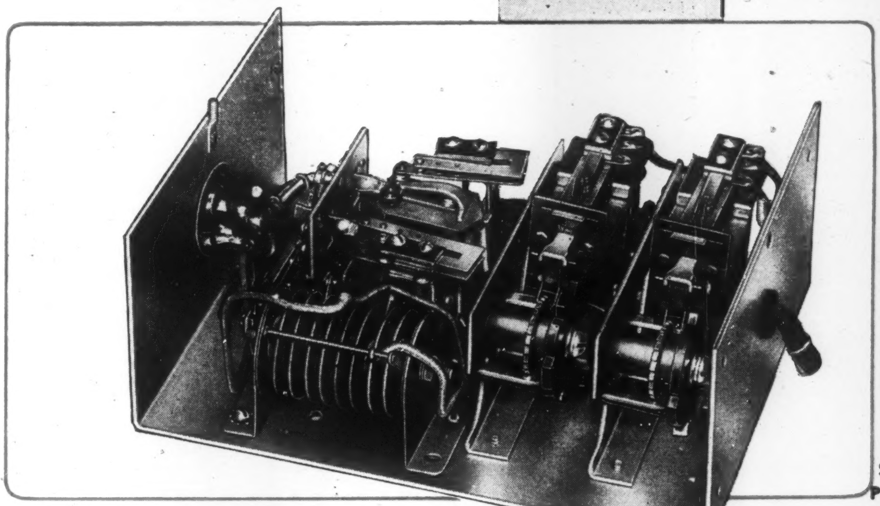
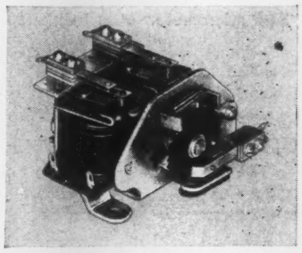
GUARDIAN'S "robot" ACCUMULATOR

WITH A MEMORY

...WITH A PULSE

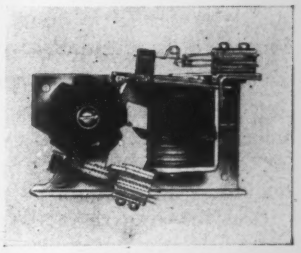






SERIES M-AS
STEPPING RELAY

SERIES S-300
PULSING RELAY



Originated by GUARDIAN

Almost human — The Guardian accumulator is a device that employs Guardian Pulsing Relays and a Guardian Stepper for storage and release of impulses. It is capable of receiving electrical pulses from a number of remote stations and storing them until each station completes its cycle or function. It can register pulses of various numerical values; for example, if three pulses are received within the accumulator and the first pulse represents a numerical value of "one", then one impulse is registered on the Stepping relay. If the second pulse has a value of "two", then two impulses are added to the previous impulse, making a total of three. If the third pulse represents a value of "five", then the five impulses are added to the three already registered, making a total of eight. The assembly will control the operation of a machine in proportion to the total number of impulses established. In the example above, the machine would be energized for eight cycles . . . one cycle for each impulse established. Unit suggests many industrial applications for Guardian Pulsing Relays and Guardian Steppers. For further information and a new cost-free Guardian Relay Catalog, write

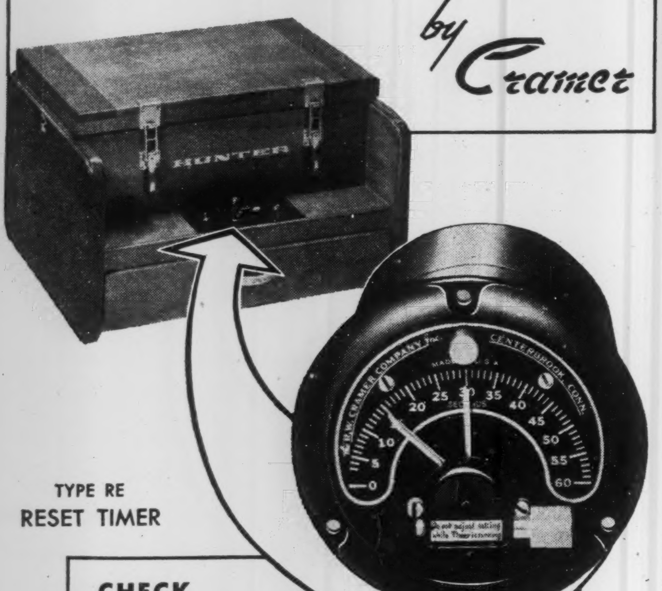
GUARDIAN ELECTRIC

1601-G W. WALNUT STREET CHICAGO 12, ILLINOIS

A COMPLETE LINE OF RELAYS SERVING AMERICAN INDUSTRY

A 10 YEAR RECORD OF PRECISION TIMING

by Cramer



TYPE RE
RESET TIMER

CHECK LIST OF DISTINCTIVE FEATURES

FUNCTION . . . manual operation of push button closes one circuit, opens the second. At end of time cycle, circuits restore to original position.

COMPACT, simple design . . . attractive appearance, trouble-free continuous operation.

EASY TO SET micrometer adjusting mechanism, full-vision scale.

PROGRESS INDICATOR travels across dial face, shows unexpired time cycle . . . returns to setting point at completion of operation.

SYNCHRONOUS MOTOR . . . precision, slow speed, self-starting . . . resets smoothly . . . rigidly mounted.

Widely used for photographic reproduction of letters, blueprints, documents and records, the Hunter Electro-Copyist is another product where accurate, dependable time control is essential to performance.

And that is why Hunter has for ten years selected Cramer Reset Timers on copying machines where automatic, electric control of exposure period is required . . . from the new, compact office machine shown above to the huge machines with 48" x 168" copying surface used in aircraft engineering departments.

Specialists in TIME as a factor of CONTROL, Cramer has developed a wide range of devices for a great variety of commercial and industrial timing duties. If the performance of your product depends on precision timing, consult Cramer.

THE R. W. CRAMER COMPANY, INC.
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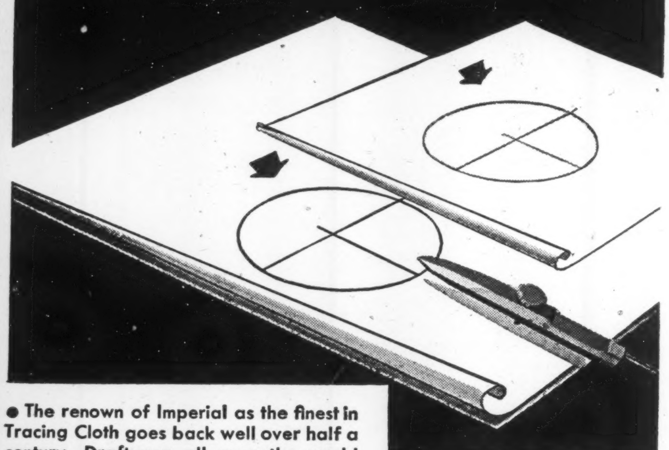

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If you like a duller surface, for clear, hard pencil lines, try Imperial Pencil Tracing Cloth. It is good for ink as well.

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If we had to go back to pre-wheel skids our civilization would wither.

TODAY

WHEELS are VITAL

Give thought to WHEELS in each of YOUR DAYS. Loads must be transported — Speeds achieved — Safety maintained — Productive effort uninterrupted. Ergo — soundly engineered and skillfully produced MODERN WHEELS are essential. During more than a half century — since our organization originated the first all-metal wheels for agriculture — the name FRENCH & HECHT has symbolized PROGRESS in the designing, testing and fabricating of TRUSTWORTHY Wheels for a myriad of important duties. Mount your mobile equipment SAFELY — on French & Hecht Wheels.

SEND YOUR WHEEL PROBLEMS TO US

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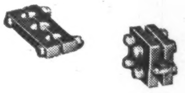
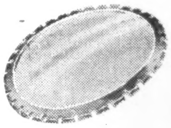
WHEEL BUILDERS SINCE 1888

...... here is PLASTIC FABRICATION engineered to your specifications





If your specifications call for strength and durability coupled with lightness in weight, better consider plastics. You get these advantages plus color, high visibility, beauty and good dielectric properties . . . with parts and assemblies held to surprisingly close tolerances. Plastics are versatile and Fabri-Form engineers can quickly choose the type best suited to your product or problem.

Plastics fabrication offers unlimited uses in all manner of shapes and forms. With Fabri-Form the entire job is worked out . . . from basic design through final production. Complete laboratory facilities are available for research and experimental projects . . . where experienced plastics engineers are constantly working to improve techniques and methods.

We know how plastic fabrication can be utilized to do a better job . . . to improve appearance and give you a better product . . . and often to reduce costs. Manufacturers of precision instruments, aircraft, boats, electrical goods, heavy machinery, automotive parts and accessories are but a few who have used and profited by our complete plastic fabrication and forming service.

Write today for facts on how plastics can be put to work for you. Ask for folder "Custom Fabrication In Plastics." M

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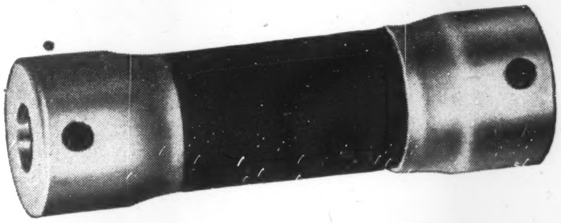

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DIRECT DRIVE COUPLINGS

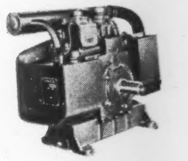
This exclusive direct drive coupling, with rubberized cushion gripped permanently by die-cast ends, has no parts to get out of order, or to lubricate. Minimizes misalignment, free end float, and backlash. Custom-made for specific job. Lengths from 2½" up. Bores 5/16", 3/8", 7/16" and 1/2". A million giving satisfactory service.

Write for sample and further details.

GUARDIAN PRODUCTS CORP.
212 E. MICHIGAN STREET MICHIGAN CITY, INDIANA

SMOOTH POWER
Two-Cylinder

The NEW ONAN
AIR-COOLED "CK" ENGINE
10 H. P. 4-CYCLE



Two-cylinder horizontal opposed design gives the new, heavy-duty CK engine unusual running smoothness. Short, rigid crankshaft . . . 2-inch diameter main and 1⅝-inch diameter rod bearings . . . pressure lubrication . . . axial-flow cooling fan . . . aluminum construction giving 4-to-1 cooling advantage over cast iron . . . weighs only 97 pounds and fits neatly into 15" x 19" x 18" space. Designed to solve engine power problems in industry, agriculture and other fields. Proven by thousands in use today . . . now in mass production . . . prompt delivery.

Also has: Built-in precision governor . . . downdraft concentric carburetor for wide-angle operation . . . oil bath air cleaner . . . fuel pump . . . oil pressure gauge . . . crankcase fumes exhausted to carburetor . . . hermetically sealed magneto ignition coil with easy-to-get-at breaker points, 2-qt. oil capacity.

ONAN ELECTRIC PLANTS—A.C.—350 to 35,000 watts in standard voltages and frequencies; D.C.—600 to 10,000 watts, 115 and 230 volts. Battery chargers—500 to 3,500 watts, 6 to 115 volts.

ONAN AIR-COOLED ENGINES—CK: 2-cylinder opposed, 10 h.p.; BH: 2-cylinder opposed, 5.5 h.p.; 1B: 1-cylinder, 2.5 h.p.

Electric Starting

Built-in electric push-button or automatic starting is optional; adds little to overall dimensions.

WRITE FOR COMPLETE SPECIFICATIONS

D. W. ONAN & SONS INC.
4337 Royalston Ave.
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ONAN *4 Cycle* ENGINES

CURTIS
CURTIS
A new Low Cost...
UNIVERSAL JOINT

**DESIGNED BY CURTIS—
MADE BY CURTIS . . .**

to meet a specific demand for a light duty *quality* joint where cost is a prime factor.

Utilizing an ingenious patented design, Curtis Engineers have developed a ball-type universal joint that combines *reduced friction* with *lower production costs.* These lower costs are being passed on to the user.

Many universal joint applications do not demand heavy duty, higher priced joints. If your problem is transmission of light torque loads around corners, or from one member to another which is slightly out of line, this new Curtis ball-type universal joint is the solution, with considerable savings in cost.

Specifications:—Curtis Ball-Type Universal

Steel forks bearing on a bronze ball, with heat-treated centerless ground pivot bearing pins. Large pin provided with oiler to enable proper lubrication of all bearing points. Ball surface offers minimum of friction loss, insuring long life for light load transmission or for hand operated controls.

Available now in 1/2" and 3/4" sizes— other sizes in production.

DEPT. B

CURTIS UNIVERSAL JOINT CO. INC.

The FLEX V TRADE-MARK

Belt Fastener for A and B Belts of open end construction

**Size No. A180 for A Belts
Size No. B214 for B Belts**

Flex V fasteners are made in two sizes for joining A and B V-belts of special open-end cross-woven fabric construction and on drives rated as light duty with a belt speed of not over 3000 feet per minute. The fasteners must not be used on heavy duty or high speed drives or for joining or repairing V-belts that were originally endless.

Flex V fasteners are easy to apply with the special applicator tool. The separable hinge joint makes for quick replacement of V-belts without dismantling shafting or machinery. Flex V fastened V-belts can also be run on V Flat Drives for there is no metal on the under side of the belt to contact the flat faced pulley.

Folder No. V-12 gives complete details on this Flex V fastener with list prices, special tools and application information. Your request will bring a copy.

Order from your supply house

FLEXIBLE STEEL LACING CO.
4686 LEXINGTON ST., CHICAGO 44, ILLINOIS

Also sole manufacturers of Alligator Steel Belt Lacing for flat transmission belts, Alligator V-belt Fasteners for V-belts and Flexco HD Belt Fasteners and Rip Plates for fastening and repairing conveyor belts.

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the recognized standard!

Manufacturers throughout the nation look to Tourek to supply their requirements for ready-made ball joints in many different styles and sizes.

For over twenty-five years Tourek *famous* Ball Joints have led in design and performance . . . their acceptance by major industries everywhere has long established them as *the recognized standard!*

Tourek's broad experience, engineering ability and production facilities are at your disposal to design and manufacture all types of special ball joints to meet your particular applications. Write today for complete data about Tourek *famous* Ball Joints.

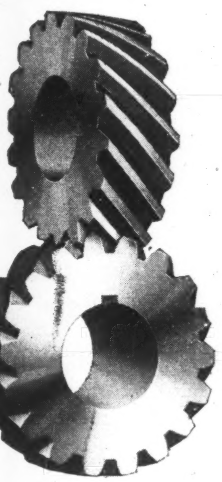
J. J. TOUREK MANUFACTURING COMPANY
4701 W. 16th Street, Chicago 50, Illinois

MAKERS OF PRECISION
SCREW MACHINE PRODUCTS

ESTABLISHED 1920
TOUREK
FAMOUS BALL JOINTS

"Industrial"

CUT GEARING—ALL TYPES AND MATERIALS
ROLLER AND SILENT CHAIN SPROCKETS



SPIRAL GEARS

MAKE IT A HABIT TO SEND US YOUR ORDERS

INDUSTRIAL GEAR MFG. CO.
4529 VAN BUREN STREET CHICAGO 24, ILLINOIS

R-10
REVERSE SWITCHES

Here is a Reverse Switch especially suited to a wide variety of applications on machine tool equipment and small hoists.

It is used for starting and reversing small A.C. and D.C. motors directly across the line without the use of magnetic reverse panels.

Operation is by pistol grip handle, with or without spring return to the OFF position, rope operated lever, or pendant mounted thumb button.

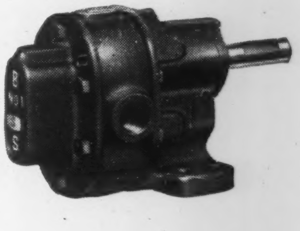
Ask for Bulletin 1002A

THE EUCLID ELECTRIC & MFG. CO.
1335 CHARDON RD. EUCLID 17, OHIO

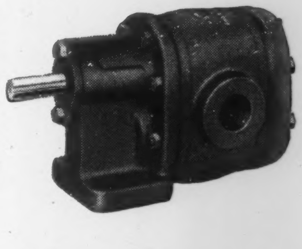
PUMPS
You can install
...and then rely on!

Because of their sturdy, simple construction and precise manufacture, Brown & Sharpe Pumps deliver smooth, economical performance year after year—with minimum attention. Their long periods of trouble-free service have led many of the country's leading manufacturers to standardize on Brown & Sharpe Pumps.

Nos. 1-S, 2-S and 3-S ROTARY GEARED PUMPS WITH HELICAL GEARS . . . Quiet, smooth performance at high speeds for supplying coolant and lubricant . . . for general circulating purposes . . . and for low pressure hydraulic service. Renewable iron bearings. Mechanical seal prevents leakage and eliminates gland adjustments. Furnished with or without integral relief valves.



Nos. 53 and 55 ROTARY GEARED PUMPS WITH ROLLER BEARINGS AND HELICAL GEARS for supplying oil under pressure for hydraulic operation of machines. Extremely accurate helical gears run quietly at motor speeds, discharging large volumes of oil at high pressures. Although designed for direct drives, can be pulley or gear driven. Mechanical seal.



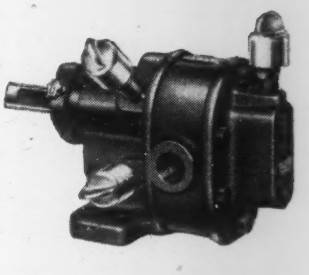
Nos. 21 and 23 BRONZE ROTARY GEARED PUMPS . . . Corrosion-resisting gears and shafts—suitable for providing circulation on water jacketed engines and for pumping saline solutions.

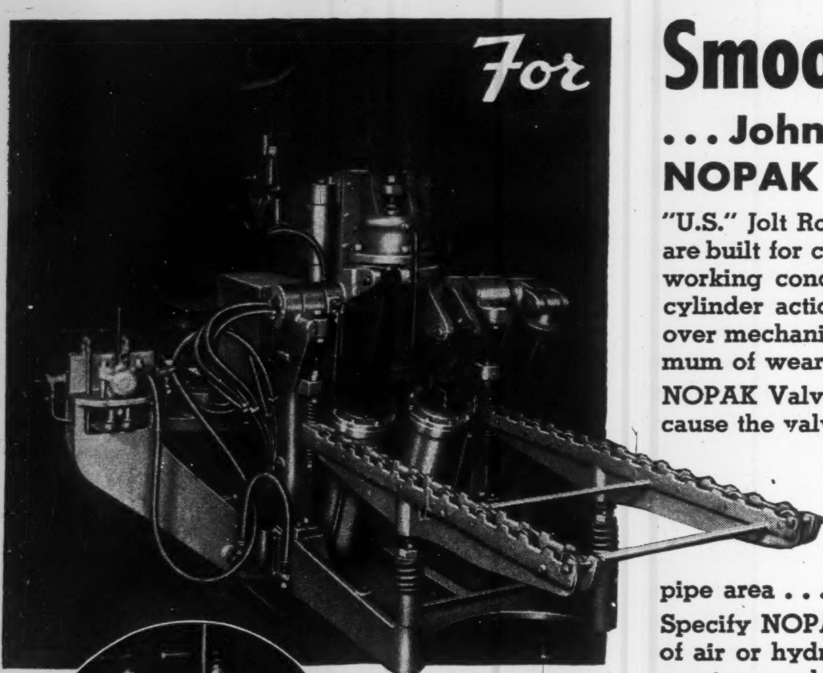
Write for catalog of complete pump line with detailed specifications. Brown & Sharpe Mfg. Co., Providence 1, R. I., U. S. A.

BS

GEARED • VANE • CENTRIFUGAL • MOTOR DRIVEN

BROWN & SHARPE
PUMPS





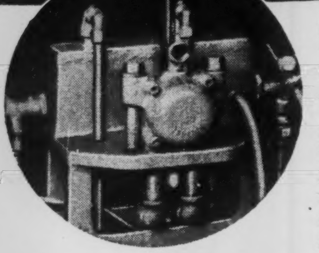
Smooth "Roll-Over"

. . . Johnston & Jennings Specifies NOPAK 5-Way Manifold Valves

"U.S." Jolt Roll-Over, Pattern-Draw Molding Machines are built for continuous, rugged service under arduous working conditions. Smooth, controlled sequence of cylinder action is required to actuate the heavy roll-over mechanism hundreds of times a day, with a minimum of wear, shock, and vibration.

NOPAK Valves are ideally suited to this purpose because the valve disc rotates at right angles to the stream flow. This basic NOPAK principle provides positive control through the complete cycle of valve operation . . . from slow, gradual, throttling action to immediate opening of full pipe area . . . without damaging shock or impact.

Specify NOPAK Valves for smooth, shockless control of air or hydraulic power, either in your plant equipment or machines you build for resale.



Johnston & Jennings "U.S." Jolt Roll-Over, Pattern Draw Molding Machine No. 815.

Left: Close-up view of NOPAK ½" 5-position Manifold Valve. This is essentially a 3-way valve for staggered actuation of 2 single-acting cylinders.

GALLAND-HENNING MFG. CO., 2752 S. 31st St., Milwaukee 7, Wis.

NOPAK

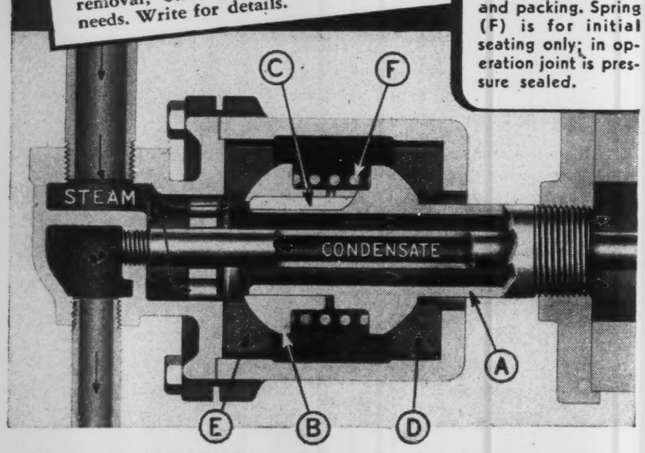
VALVES AND CYLINDERS

DESIGNED for AIR and HYDRAULIC SERVICE

GOT A JOB FOR JOHNSON JOINTS ?

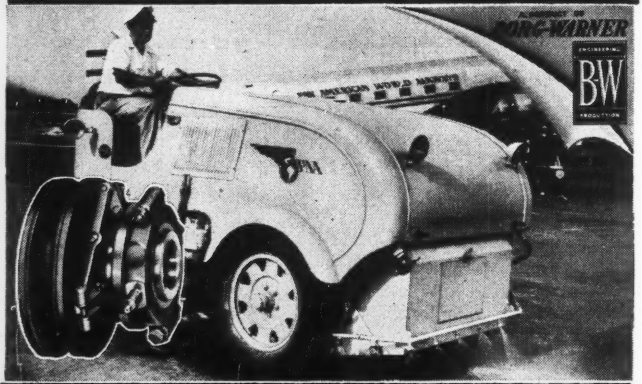
You have if you're faced with a problem that involves getting steam or liquids into rotating machine parts. The Johnson Rotary Pressure Joint is completely packless, self-oiling, self-adjusting, and even self-aligning. Industry has already put 100,000 to work, in barely ten years. Type B shown provides for condensate removal; other types and sizes for all needs. Write for details.

Nipple (A) connected to roll or drum. Sliding collar (B) keyed (C) to nipple. Carbon - graphite seal ring (D) and bearing ring (E) eliminate oiling and packing. Spring (F) is for initial seating only; in operation joint is pressure sealed.



THE JOHNSON CORPORATION
811 Wood St., Three Rivers, Michigan

ROCKFORD



LIGHT OVER-CENTER CLUTCHES

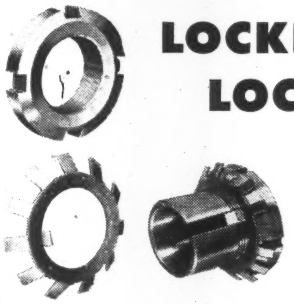
- COMPACT DESIGN
- POWERFUL PULL
- SMOOTH ENGAGEMENT
- UNIFORM PRESSURE
- FINE ADJUSTMENT
- ACCURATE BALANCE *
- LONG SERVICE LIFE

* ROCKFORD Light Over-Center CLUTCHES are carefully balanced to prevent drag or centrifugal force from affecting their smooth running operation. A separate operation accurately checks the balance of each ROCKFORD Light Over-Center CLUTCH, within close limits, before it passes final inspection.

SEND FOR THIS HANDY BULLETIN

Shows typical installations of ROCKFORD CLUTCHES and POWER TAKE-OFFS. Contains diagrams of unique applications. Furnishes capacity tables, dimensions and complete specifications.

ROCKFORD CLUTCH DIVISION BORG-WARNER
311 Catherine Street, Rockford, Illinois, U. S. A.



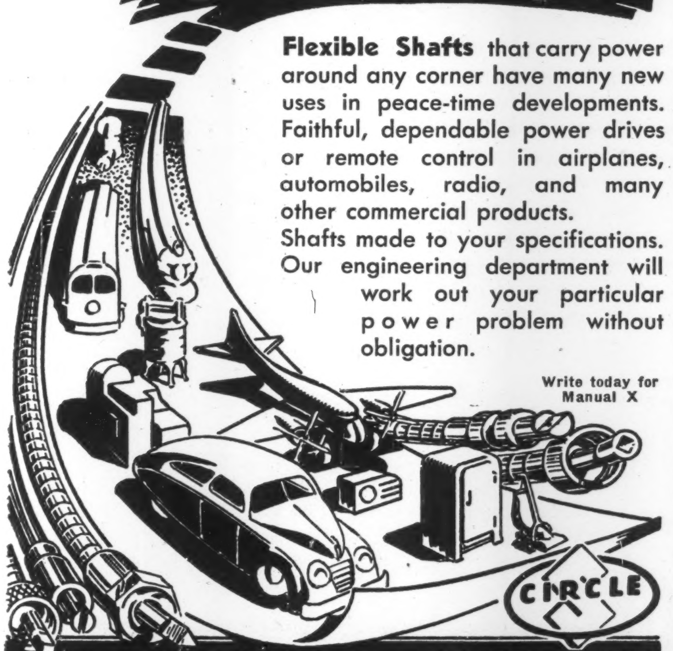
LOCKNUTS, LOCKWASHERS and ADAPTERS

Order now from our complete stock of Locknuts, Lockwashers, and Adapters for your application of ball and roller bearings . . . S.A.E. Standard . . . A.B.E.C. Standard . . . Heavy-duty and Specials.

Locknuts in sizes N-00 through An-40, and new multi-prong type Lockwashers in sizes W-00 through W-40 can be delivered immediately. (Write for Bulletin 27 containing complete specifications.)

Adapter sizes 7-9-11-13 . . . for shaft sizes $1\frac{3}{16}$"-$1\frac{7}{16}$"-$1\frac{15}{16}$"-$2\frac{3}{16}$".

STANDARD LOCKNUT & LOCKWASHER, INC.
311 N. Capitol Ave. Indianapolis, 4 Indiana



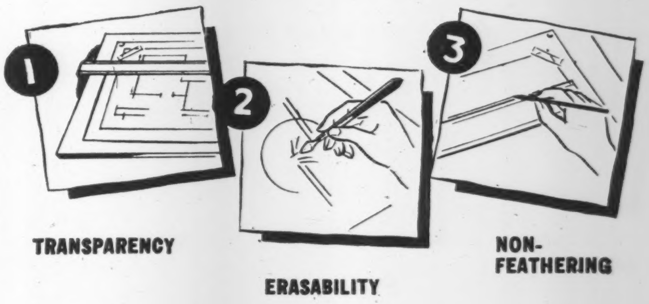
FLEXIBLE SHAFTS

Flexible Shafts that carry power around any corner have many new uses in peace-time developments. Faithful, dependable power drives or remote control in airplanes, automobiles, radio, and many other commercial products.
Shafts made to your specifications. Our engineering department will work out your particular power problem without obligation.

Write today for Manual X

F. W. STEWART MFG. CORPORATION
4311-13 RAVENSWOOD AVE. CHICAGO 13, ILL.
WEST COAST BRANCH: 431 Venice Blvd.; Los Angeles 15, Cal.

GIVE YOUR TRACING CLOTH
the 1 • 2 • 3 • test—


1
2
3
TRANSPARENCY
ERASABILITY
NON-FEATHERING

MICRO-WEAVE and PEL-X
win on ALL three

Whatever you want most in a tracing cloth, you'll find it in these two great products of Holliston Mills. Try them both and you'll agree: it pays to make sure you get "all three": maximum transparency and maximum erasability and minimum feathering.

Send for Samples.

Micro-Weave
All American
TRACING CLOTH
PEN OR PENCIL
Micro-Weave
All American
WHITE PENCIL CLOTH
24 YARDS
THE HOLLISTON MILLS, INC.
PEL-X
WATER REPELLENT
TRACING CLOTH
WHITE PENCIL
PEL-X
WATER REPELLENT
TRACING CLOTH

MICRO-WEAVE, in white or blue, for ink or pencil.

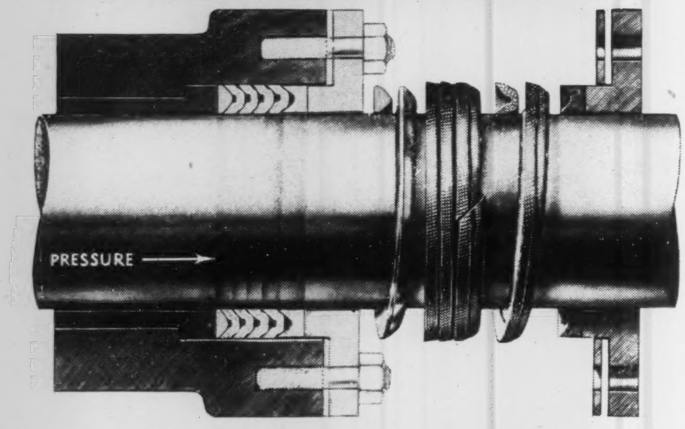
PEL-X, white pencil, water repellent.

THE HOLLISTON MILLS, INC.
NORWOOD, MASSACHUSETTS
NEW YORK • CHICAGO

LINEAR

"PAR" PACKINGS

A FLUID TIGHT SEAL



"Par" Packings are the result of nearly 15 years of extensive research and experimentation. They are available in six standard compositions to cover an exceptionally wide range of operating conditions. "Par" Packings are compounded from synthetic polymers (reinforced with duck or asbestos fabric for extra strength and durability) and designed especially for the recommended service.

"PAR" PACKING RECOMMENDATION CHART

TEMP. RANGE(°F.)	0-2000 P.S.I.					2000 P.S.I. & UP			
	AIR	GAS	WATER	STEAM	OIL	AIR	GAS	WATER	OIL
	STYLE No.	STYLE No.	STYLE No.	STYLE No.	STYLE No.	STYLE No.	STYLE No.	STYLE No.	STYLE No.
0-180	870	860	860		861	865	865	865	865
180-250	870	870	865	865	861	873	873	865	865
250-UP	870	870		870	871	873	873		873

NOTE: These recommendations indicate the normal operating conditions encountered and are, of necessity, rather general in nature. They should not be interpreted as maximum limits, since numerous installations are successfully operating at temperatures and pressures considerably in excess of those shown. Write for full details.

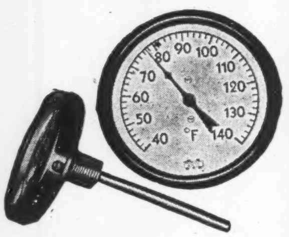
LINEAR
INCORPORATED
Executive Offices and Factory
STATE ROAD and LEVICK STREET—PHILADELPHIA 35, PENNA.

MARSHALLTOWN

DIAL THERMOMETERS

THE COMPLETE LINE

NEW! Stainless Steel Bulb and Nut!

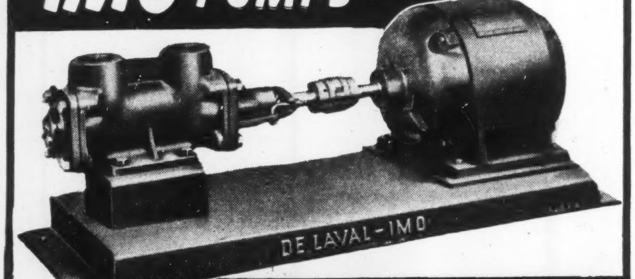


WRITE TODAY FOR FULL DETAILS AND PRICES

Now furnished in stainless steel bulb and nut, an accurate, compact, durable instrument for the indication of liquid or gas temperatures. They are available in a variety of temperature ranges—from minus 40° F. to plus 500° F. Actuation is positive, direct with full freedom—no gears or pinions. Available in sizes 2", 2½", 3½" and 4½".

Marshalltown Mfg. Co., Marshalltown, Iowa

IMO PUMPS



PERMIT DIRECT DRIVE AT ANY SPEED

The IMO pump can be connected directly to turbines, motors or other machinery without the use of reduction gears.

Operated at high speed, it is exceptionally small and compact in proportion to its capacity.

IMO pumps can be furnished for almost any capacity and pressure required for pumping oil, hydraulic control fluids and other liquids over a wide viscosity range.

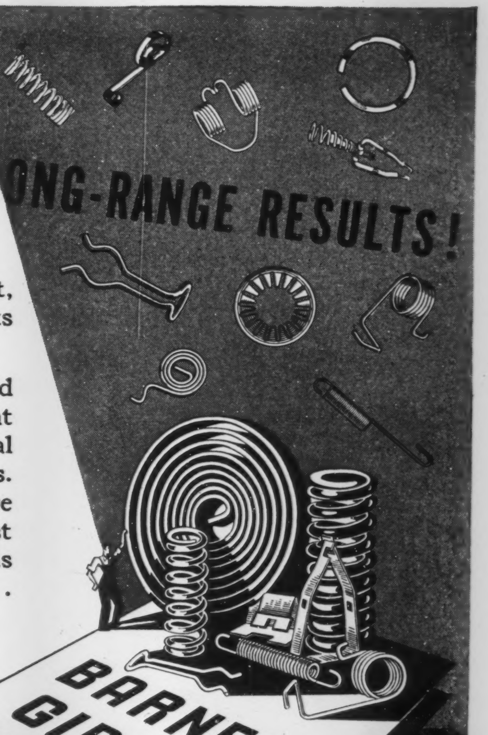
For further information send for catalog I-138-D

IMO
PUMP DIVISION of the
DE LAVAL STEAM TURBINE CO.
TRENTON 2, NEW JERSEY

A "LOOK-SEE" PAYS . . . FOR LONG-RANGE RESULTS!

If there's a spring involved in your product, don't overlook any factor that may add to its live action and long life.

B-G-R engineers help you track down and overcome the difficulties that sometimes crop up in mechanical actions depending on springs. They will design and produce the type of spring to give best results for your purpose. This service saves time and trouble. . . and ofttimes money.



START RIGHT

call on B-G-R early in
your developments.
Build your mechanisms
around B-G-R

SPRINGS
Wire Forms
Small Stampings

BARNES-
GIBSON-
RAYMOND

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DIVISION OF
ASSOCIATED SPRING CORPORATION

TWO
PLANTS
FOR
SPRING SERVICE

DETROIT 11, MICHIGAN
ANN ARBOR, MICHIGAN

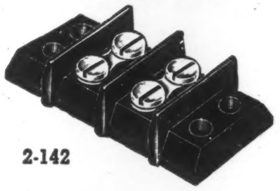
JONES BARRIER
TERMINAL STRIPS

Bakelite Barriers placed between Terminals increase the leakage path and prevent direct shorts from frayed wires at Terminals. Terminals and screws are of nickel plated brass. Insulation is of BM 120 molded Bakelite. Illustrated are three types: Screw Terminals, Screw and Solder Terminals and Screw Terminal above Panel with solder Terminal below. Every type of connection.

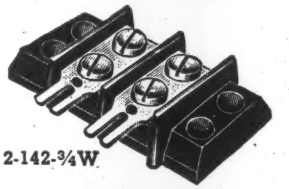
Six series cover every requirement: No. 140—5-40 screws, No. 141—6-32 screws, No. 142—8-32 screws, No. 150—10-32 screws, No. 151—12-32 screws and No. 152—¼-28 screws.

These sturdy Terminal Strips will not only improve your electrical connections but will add considerably to the appearance of your equipment.

Write today for catalog No. 14 listing our complete line of Barrier Strips in addition to other Electrical Connecting Devices.



2-142



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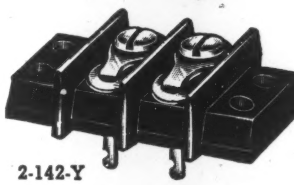


2-142-Y

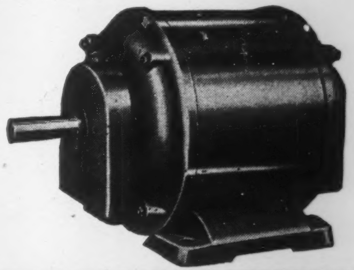
HOWARD B. JONES DIVISION
CINCH MFG. CORP.
2460 W. GEORGE ST. CHICAGO 18

Design Engineers Specify

VALLEY
Ball Bearing
MOTORS

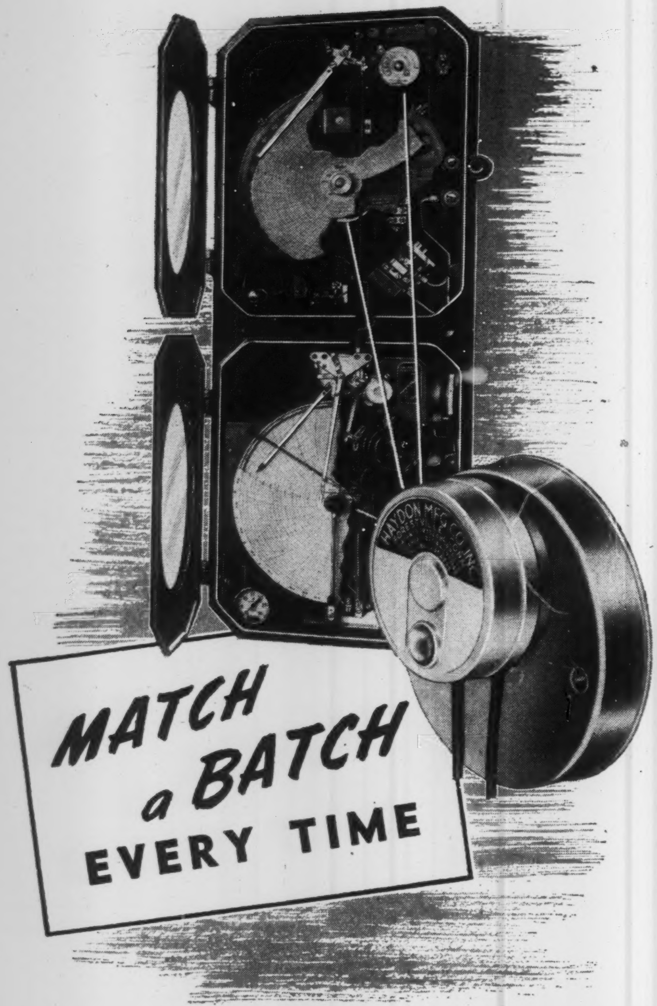
Because-

- ● They offer more flexibility in power planning.
- ● They are built to meet unusual power loads and high temperatures.
- ● They meet all operating conditions where hazards of liquids, chips, etc., dropping into the motor are involved; as well as splash conditions.
- ● Being made in ½ to 75 h. p. sizes, they offer wide adaptability.



Valley

VALLEY
ELECTRIC CORPORATION
4221 Forest Park Blvd. • St. Louis 8, Missouri



Textile, rubber, food, chemical, paper and petroleum industries are depending upon Taylor Time Schedule Controllers for complex batch processing . . . high-quality and economical production involving time with temperature, pressure, flow or liquid level.

To match a batch, three Haydon timing motors (two chart drives and one interrupter timer) are employed in the Taylor Schedule Controller. The Controller carries through a prescribed time interval and concludes automatically. During the process cycle, auxiliary devices are precisely synchronized and the controller resets itself for consistent and dependable production. This and many other Haydon applications are accounting for greater timing accuracies throughout industry.

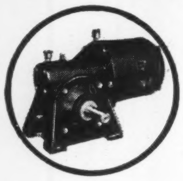
If it's about time, rely on Haydon in Forestville, Connecticut to deliver. Write for free engineering catalog.

Haydon 2700 Forest Street, Forestville, Conn.

HAYDON

MANUFACTURING COMPANY, INC.
FORESTVILLE CONNECTICUT
HARNESS TIME TO YOUR PRODUCTS
SUBSIDIARY OF GENERAL TIME INSTRUMENTS CORPORATION

Speed REDUCERS



1/20
to
7 1/2
H.P.

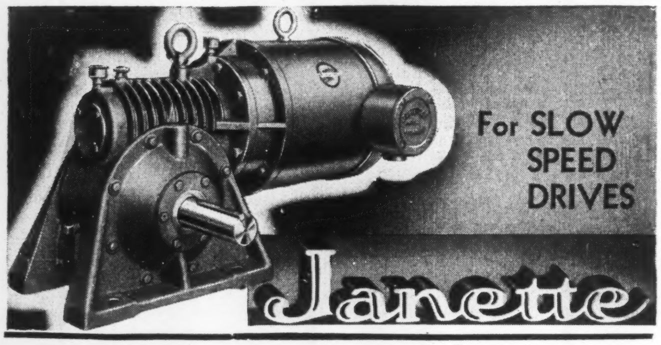
ONE Source of Supply
for Motorized and Motorless Speed Reducers

We build BOTH kinds, as well as the special Janette Motors used for driving our motorized speed reducers.

These machines are built with foot or flange mounting bases, for 1/20 to 7 1/2 h. p. and deliver slow speeds of from .08 to 450 r.p.m. A wide diversity of mounting positions simplifies assembly to a driven machine.

ASK FOR CATALOG 22-27

Janette Manufacturing Co.
556 W. Monroe St. Chicago 6, Illinois



Punch Control
IN THE ROUGH

Dependable . . .
BECAUSE THEY'RE FORGED!

When these forgings of 50 Car., Chr., Moly., alloy water hardening steel are finish machined, they'll be punch press wedges for controlling heavy ram blows to suit various applications.

Call us for special quality forged steel parts.

Smith-Armstrong FORGE, INC.
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POWER *Flow*

ONLY AS TRUE, DEPENDABLE AND *EFFICIENT* as its COUPLING

Pat. and Pats. Pend.

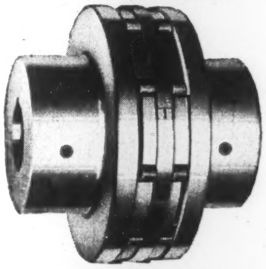
From Type "A" for fractional h.p. to 50 h.p.

to

Type "W" for heavy duties, to 2500 h.p. and weighing from 9 to 3000 lbs.

LOVEJOY L-R
Flexible Couplings

Resilient Alignment Types *simplest,* most rugged insurance of true performance—correction for misalignment, takeup of shock and vibration, backlash, chatter, etc. The *quiet couplings!* Send for complete catalog, with Selector Charts for quickest finding of couplings you need.



Pat. and Pats. Pend.

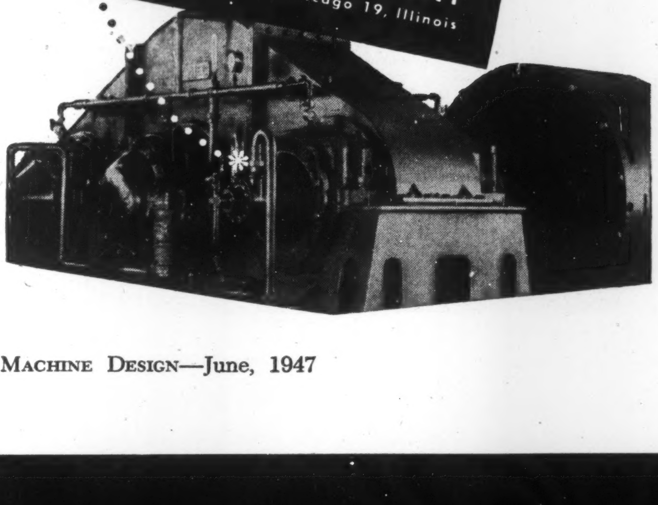
LOVEJOY FLEXIBLE COUPLING CO.
5018 W. Lake St. Chicago 44, Ill.

Also mfrs. of Lovejoy-IDEAL Variable Speed Transmissions

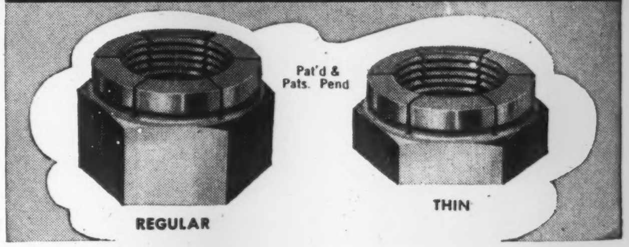
NO OTHER PUMPS FIT THE JOB LIKE TUTHILL STRIPPED PUMPS

Tuthill Stripped Pumps are designed for building directly into machines to save space, improve appearance and reduce costs. Two types available: Type S, furnished without mounting bracket; and Type SA which provides pumping elements only. Ideal for lubrication, coolant, hydraulic and liquid transfer service. Capacities up to 200 g.p.m. Write for Tuthill Stripped Pump Bulletin.

TUTHILL PUMP COMPANY
939 East 95th Street • Chicago 19, Illinois



FLEXLOC



SELF-LOCKING NUTS

Samples of our Flexloc Self-Locking Nuts will be sent free.

"Flexloc" packs maximum usefulness in minimum space because it is rugged, self - locking, compact—and is therefore becoming increasingly popular and this applies alike to U.S.S. and S.A.E. thread series.

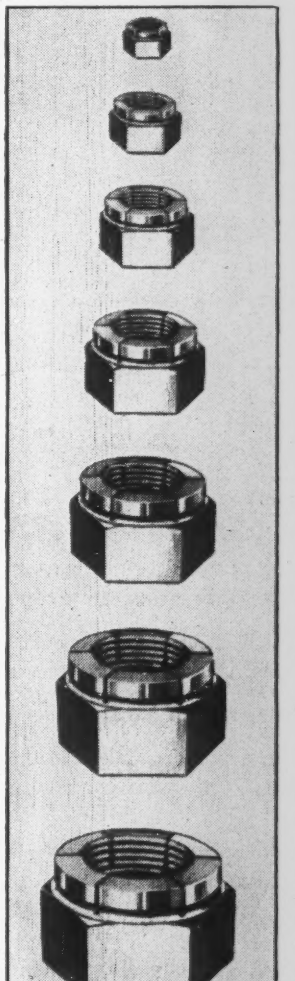
Every thread — including the locking threads—takes its share of the load.

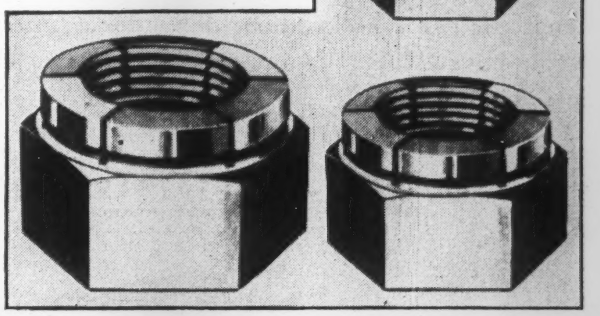
Covers a wide range of tolerances—from low No. 1 to high No. 3. Can be used over and over again without losing much of its locking ability.

Being a "stop" nut, it stays locked in any position on a threaded member. "Flexloc" Thin Nuts are especially popular, because their tensile is so high.

Sizes from No. 6 to 1" in diameter — **millions in use!**

Convince yourself with a few free samples.





OVER 44 YEARS IN BUSINESS

STANDARD PRESSED STEEL CO.
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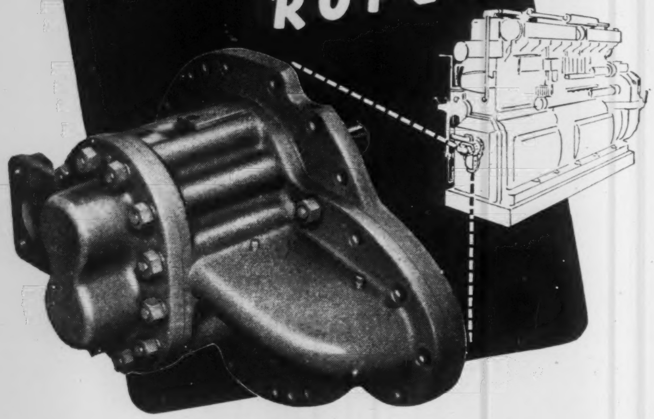
SPECIAL-BUILT *Streamlined* PUMP by ROPER



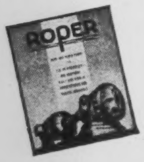
Compactly Designed—Operates at Higher Speed

Here is another example of a special built Roper Rotary Pump, designed for a prominent engine builder, to suit specific needs.

It is built to operate at a faster speed than the ordinary positive displacement pump . . . therefore, it is more compact and requires less space.

Designed for Diesel lube oil service it has a rated capacity of 267 g.p.m. operating at 1160 r.p.m. at 90 lbs. p.s.i.

Whatever your pumping problems may be, call on Roper for assistance without obligation. There is a convenient Roper engineering and service office near you.

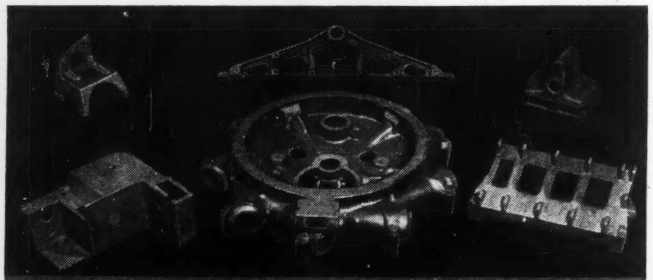


SEND FOR CATALOG TODAY

Illustrating and describing pumps built to handle pressures up to 1000 lbs. p.s.i., capacities ¾ to 300 g.p.m. at speeds up to 1800 r.p.m.

GEO. D. ROPER CORP.
246 Blackhawk Park Avenue
ROCKFORD, ILLINOIS

ROPER *Rotary Pumps*



Magnesium Castings

Lighter • Stronger • Easier to Fabricate

Don't let the original cost of magnesium confuse you—often their excellent machining qualities make magnesium castings cost *less* than those of the more common metals, and usually they *cost no more!* Let Utica Radiator design engineers and metallurgists solve your problems in castings—with magnesium!

Write for this booklet on our Production Facilities

It's the story of light-weight, strong, shock-resistant magnesium . . . and Utica Radiator's production facilities for handling your problems. Write for it at once!

Utica Radiator Corporation
Manufacturers of Magnesium Castings for Industry
2240 Dwyer Avenue • Utica 2, New York

SO DEPENDABLE!

DRAKE PILOT LIGHT ASSEMBLIES

They do the job better and more economically

DRAKE Socket and Jewel Light Assemblies are built to highest standards, yet cost no more than ordinary types. There is a COMPLETE selection of standard types, special types, "Underwriter's Approved" Types, Bayonet, Screw and Bracket Types, Neon, Jewel Types . . and hundreds of others. Or we can custom-build an Assembly for your special requirements.

➡ **ENGINEERS** Drake Assemblies are designed with a safety factor adequate to meet varying conditions. Materials and workmanship are highest grade. Our engineers will co-operate with you on your Pilot Light problems . . no obligation.

➡ **MANUFACTURERS** Get the benefit of our patented features, of high speed precision methods and machinery developed thru 15 years of *specializing* in making Socket and Jewel Light Assemblies.

➡ **PRODUCT DESIGNERS** Add a DRAKE Light Assembly to your specifications . . for on or off signals, for illumination, for warning signals. They often mean that "extra something" that clinches a sale. Be sure to "SPECIFY DRAKE" for the finest.

ASK FOR A FREE COPY OF OUR CATALOG, TODAY

DRAKE MANUFACTURING CO.
1713 W. HUBBARD STREET • CHICAGO 22

AVAILABLE NOW! by The Million!

WASHERS

Made of

ASBESTOS

NEOPRENE

CORK

RUBBER

and many other materials

"Right Away," all the washers you want! You know how vitally important a little washer can be... how it can ruin your product's performance—and reputation, if the washer is loose, defective or missing. No excuse now, when you can get plenty of **good** washers immediately from Fel-Pro. Fel-Pro's plants make this prompt service possible. If you need a special type of washer to meet some unusual condition, Fel-Pro engineers will be glad to work with you. Hundreds of manufacturers look to Fel-Pro as "Washer Headquarters". **SEND FOR FREE FOLIO** containing 53 Sample materials for Washers, Gaskets, Die Cuts, Packings, etc. Write 2126

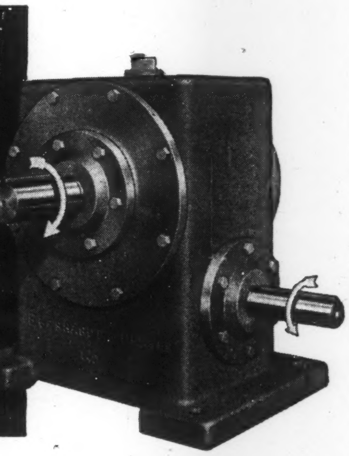
INDUSTRIAL GASKETS AND PACKING DIVISION OF FELT PRODUCTS MFG. CO., 1517 Carroll Ave., Chicago 7, Ill.

FEL-PRO

for ORIGINAL EQUIPMENT requirements

Speed Reducers

FROM STOCK



Manufactured in a practical range of sizes and reductions. We also build reducers to meet special needs.

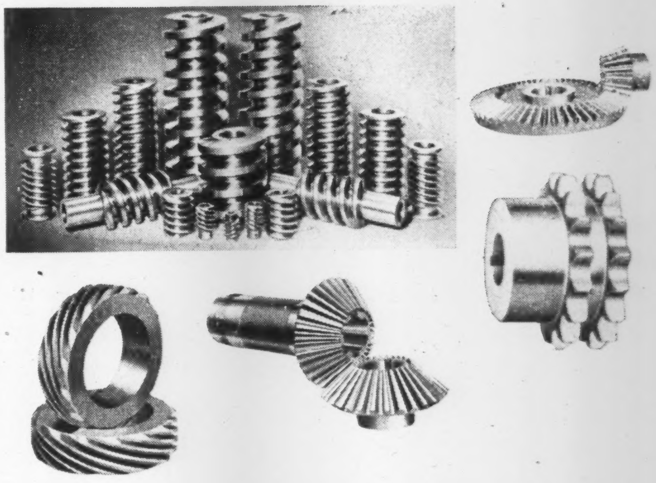
EBERHARDT DENVER

CALL US LONG DISTANCE

Eberhardt-Denver Co.

GEARS AND SPEED REDUCERS

1416 West Colfax Ave., Denver 4, Colorado Phone TAbor 7134



Are you looking for ways to improve your product?

Check these advantages of Adams custom made gears

- √Made by skilled gear craftsmen.
- √Cut on modern precision machines.
- √Careful inspection and control throughout manufacture.
- √Exact conformance with your specifications.

Adams gears are made to suit the particular requirements of your product and to make that product perform as efficiently and dependably as possible. Investigate the advantages of Adams custom made gears for your needs. Write THE ADAMS COMPANY, 1942 Tower St., Dubuque, Iowa.

the ADAMS line

Spur Gears
Helical Gears
Bevel and Miter Gears
Worms and Worm Gears
Sprockets
Internal Gears
  (Spur and Helical)
Ratchets
Splined Shafts
Racks
Lead and Feed Screws
Ground Tooth Gears
  (Spur and Helical)
Shaved Tooth Gears
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Ground Thread Worms

The ADAMS Company

Dubuque, Iowa, U. S. A.

ESTABLISHED 1883

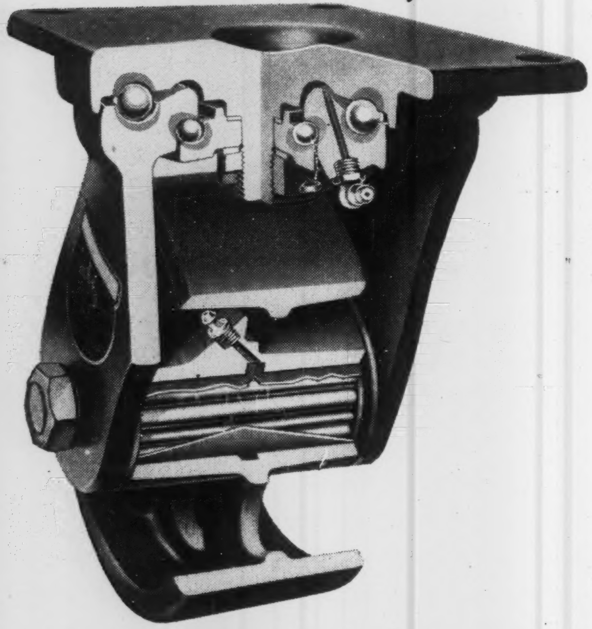
GEARS

FINE GEARS MADE TO YOUR SPECIFICATIONS

RAPIDS-STANDARD CASTERS

STEEL-FORGED FOR

Strength



FLAME-HARDENED FOR

LONG-*Wear*

Rapids-Standard Casters are made of drop-forged SAE 1045 steel for maximum strength and greatest overload capacity. Under the toughest running conditions — shock loads, continuous operation, constant overloading — these tough casters will continue to roll easily and smoothly.

The swivel bearing ball races are flame hardened to combine extreme hardness at contact points with tough shock resistance in the caster body. As a result, Rapids-Standard Casters continue to swivel smoothly and run without wobble long after other casters have been replaced.

Rapids-Standard casters come in both rigid and swivel types with a choice of bearing depending upon the service for which they are intended. Wheel types include Nicro-Steel, Forged Steel, Resinoid and Rubber. Rapids-Standard offers a bearing and wheel combination to exactly suit your application in a capacity for any type of industrial application.

The new Rapids-Standard Caster Catalog is now ready. It contains complete specifications on sizes, types, capacities together with suggestions for more efficient caster use. Write for your copy today.

OFFICES IN PRINCIPAL CITIES

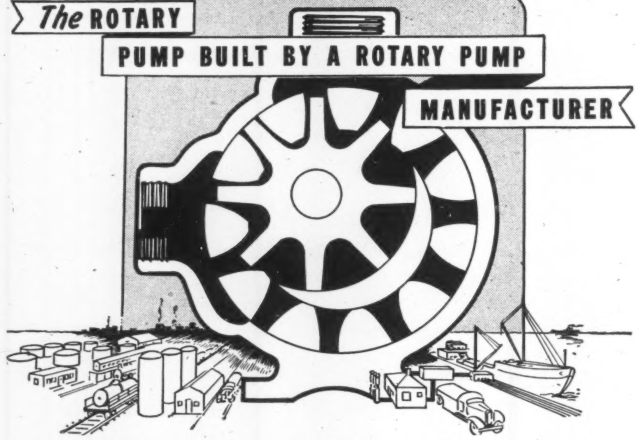
Manufacturers of
STEEL FORGED CASTERS · TRUCKS & CONVEYORS · POWER BOOSTERS

The Rapids-Standard Co., Inc.

Sales Div.—330 Peoples Nat'l Bank Bldg., Grand Rapids 2, Mich.

VIKING

The ROTARY PUMP BUILT BY A ROTARY PUMP MANUFACTURER



Viking Rotary Pumps are no side-line business. They are no fill-in. Making Viking Rotary Pumps is our one and only job. That is why you get so much from a Viking Pump.

It's an exclusive Viking product . . . in design . . . in production . . . in service. Every effort is extended toward the betterment of this one product. Every design is based on a "gear-within-a-gear—2 moving parts" principle. All production is concentrated on this one style pump. Service is simplified by the same means.

Discover for yourself this outstanding rotary pump. Write today for free folder Bulletin Series 47SH. It will be sent to you by return mail.

See Our Catalog In SWEETS

VIKING PUMP COMPANY
CEDAR FALLS, IOWA

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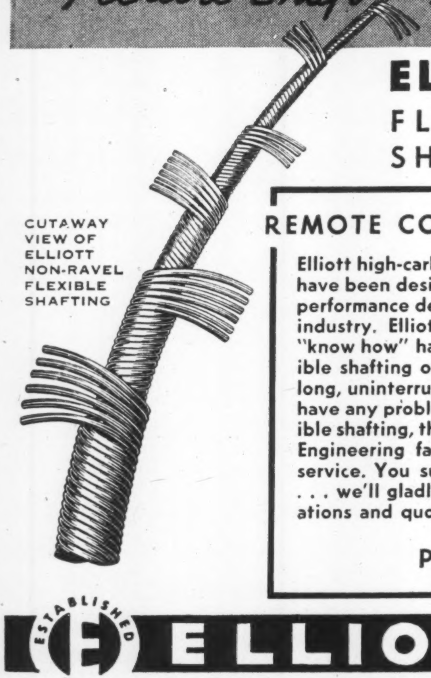
the backbone OF GOOD *Flexible Shaft Assemblies* IS



CUTAWAY VIEW OF ELLIOTT NON-RAVEL FLEXIBLE SHAFTING

ELLIOTT FLEXIBLE SHAFTING

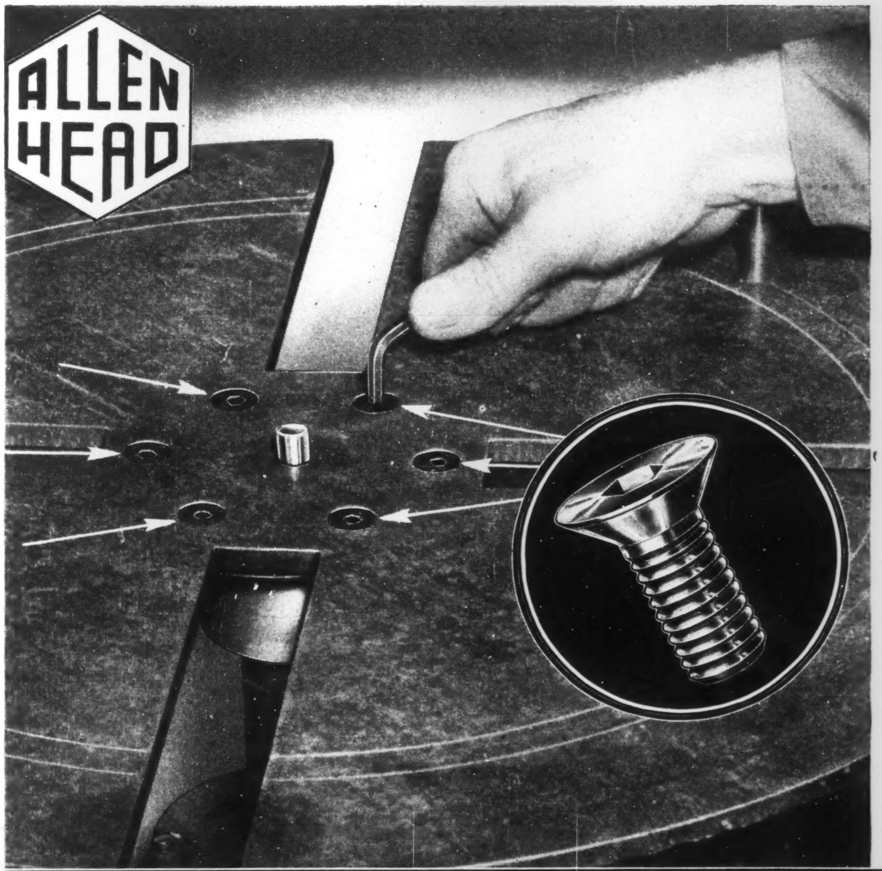
REMOTE CONTROLS

Elliott high-carbon music wire cores have been designed for the rugged performance demanded by modern industry. Elliott workmanship and "know how" have developed flexible shafting of top quality to give long, uninterrupted service. If you have any problem to do with flexible shafting, the Elliott Design and Engineering facilities are at your service. You supply specifications . . . we'll gladly send recommendations and quotations.

POWER DRIVES

ESTABLISHED 1932

ELLIOTT
MANUFACTURING COMPANY
217 PROSPECT AVE. BINGHAMTON, N. Y.



ALLEN

FLAT HEAD CAP SCREWS provide a flush top surface

on the casting plate of a centrifugal casting machine, with no gap between the screw heads and surrounding metal. Six Allen hex-socket screws fasten the casting plate to the supporting arbor. The strength of these *"pressur-formd" ALLENOY* steel screws permit the tightest of set-ups; their high Class 3 fit adds to HOLDING-POWER. Extreme rigidity is achieved because angle of screw-head locks screw in place by drawing down on a conical surface.

Order of your local Industrial Distributor.

The Allen Mfg. Company ★ ALLEN ★ Hartford, Conn., U. S. A.

EWC WHEELS

Engineered for YOUR Product

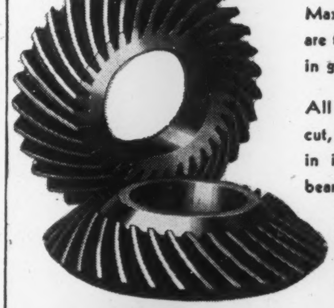
There is a wide variety of EWC wheels and axles for every type of mobile equipment . . . one or several may be ideally suited to your product. For unusual wheel problems, we offer you a complete engineering service, with a thoroughly experienced staff and unexcelled facilities. Write today for complete information.

ELECTRIC WHEEL CO., Quincy, Illinois, Est. 1890

CINCINNATI . . .

Spiral Bevel Gears

HAVE MUCH TO OFFER



Maximum performance and dependability are two qualities that are absolutely essential in gears for any industrial purpose.

All Cincinnati Spiral Bevel Gears are cut, tested, matched, lapped and marked in individual sets . . . to insure correct bearing location on teeth.

For smooth, efficient operation at high speeds . . . specify Cincinnati Gears, *Good Gears Only!*

THE CINCINNATI GEAR COMPANY

"Gears . . . Good Gears Only"

Wooster Pike and Mariemont Ave. ★ Cincinnati 27, Ohio

CONVEYOR MANUFACTURERS!

Step ahead of competition with amazing food conveyor belting

When you manufacture conveyors for food, drug, chemical and other users whose products are moist, sticky or odorous . . . your equipment may be as modern as tomorrow . . . but what about the belting? Shouldn't it be expected to give your users maximum satisfaction, too? Yes, and it will . . . if it's PlasTex belting.

What is PlasTex?

PlasTex is a fully pliable, odorless, plastic coated, solid woven belting that cleans easily, won't pick up odors, and will resist temperatures up to +240°F. There's simply nothing else like PlasTex for appearance, sanitation and long life.

A New Selling Feature For You

PlasTex is already proved in use by hundreds of leading food, drug and chemical processors. Why not bring its benefits to buyers of your equipment? May we discuss this with you?

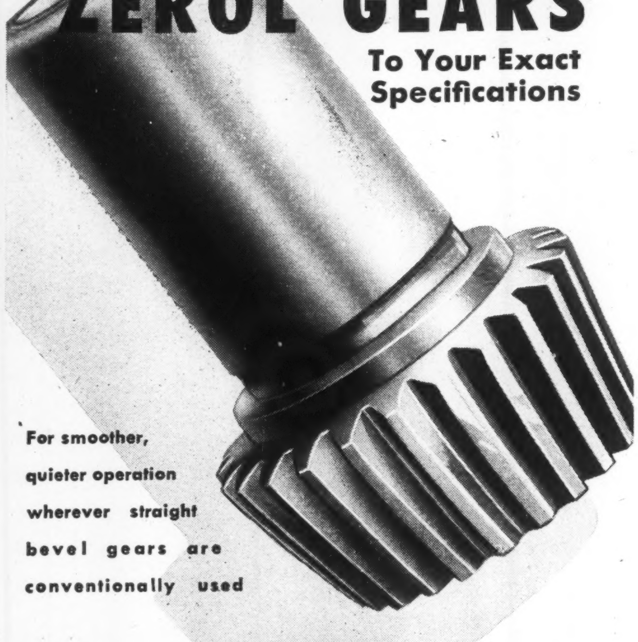
BUFFALO WEAVING AND BELTING COMPANY

BUFFALO 7, NEW YORK

NEW YORK CHICAGO

ZEROL GEARS

To Your Exact Specifications



For smoother, quieter operation wherever straight bevel gears are conventionally used

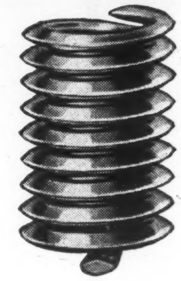
Write for Bulletin on Gear Jobbing Service —Our Specialty for More Than 30 Years

DETROIT BEVEL GEAR CO.

8130 JOS. CAMPAU • DETROIT 11, MICH.

HELI-COIL* Inserts

repair stripped threads . . . broken studs . . . in 3 easy steps:



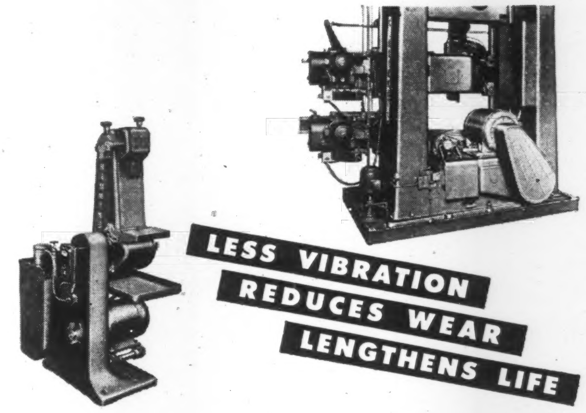
1. *Drill out bad thread or broken stud*
2. *Tap new thread*
3. *Install a Heli-Coil*

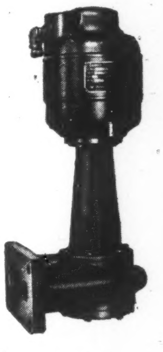
Removing broken studs and repairing stripped threads used to be a tough job. Now, smart servicemen are using Heli-Coil Inserts for quick, economical thread repairs. These precision-formed coils of stainless steel or phosphor bronze wire are made to fit U.S.S. and S.A.E. threads and spark plug holes. They act as an anti-friction thread lining—resisting abrasion, corrosion, seizing and stripping. Write for helpful thread repair literature.

* Reg. U. S. Pat. Off.

AIRCRAFT SCREW PRODUCTS COMPANY, INC

47-23K 35th STREET • LONG ISLAND CITY 1, N. Y.





Model 11020

RUTHMAN GUSHER

COOLANT PUMPS

The entire rotating assembly of every Ruthman Pump is electronically balanced, assuring alignment and vibrationless rigidity of the shaft. Vibration is cut to a minimum, wear is reduced, and a long trouble-free life for your Ruthman Gusher Coolant Pump is assured.

Illustrated on the left is a Hammond 6" Model VH-6 Abrasive Belt Grinder equipped with a Model 1-P3-1/10 HP Short Ruthman Gusher Pump. On the right is a Cincinnati Planer Company 64" Vertical Boring and Turning Mill equipped with a Model 11023-A Long Ruthman Gusher Coolant Pump. Follow the leading manufacturers of machine tools and equip your machines with Gusher Coolant Pumps.

Write for Catalog 10-C

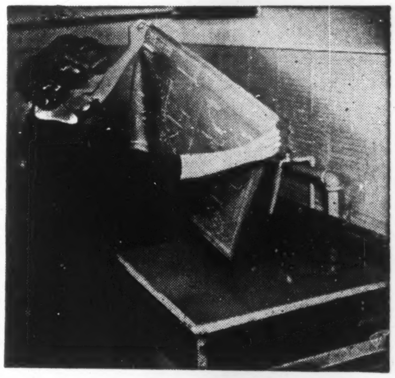
THE RUTHMAN MACHINERY CO.

1811 Reading Road • Cincinnati, Ohio

HI-TENSED Blueprints

[Replacing Potash]

Are Sharper—Clearer
Hold Color Longer—
SOLUTION IS NON-STAINING NON-CORROSIVE



OPERATOR IS Protected Against "BLUEPRINT RASH"

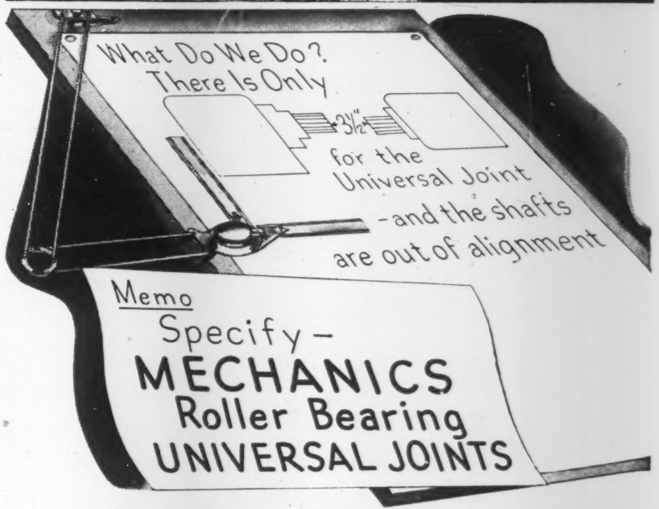
Hands can be completely immersed in *Hi-Tense Concentrate* Blueprint Developing Solution without danger of irritation or caustic dermatitis. Doesn't stain equipment, walls or clothing. Non-corrosive to tank, equipment or plumbing. Produces exceptionally sharp, clear blueprints. Pint bottle makes 40 gallons of solution. Consistently used by leading industrial concerns. Try a case of 6 bottles at $8.10. Order from your drafting supply jobber—*or direct,* if he can't supply you.

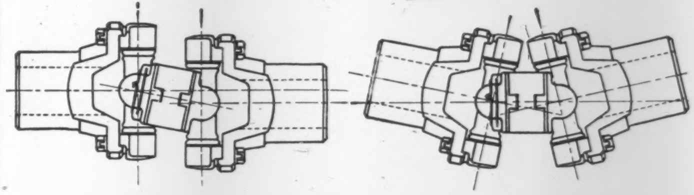
HI-TENSE
CONCENTRATE

WISCONSIN PHARMACAL CO.

221 N. Water Street, Milwaukee 2, Wis.

What Would You Do About A Problem Such As This?



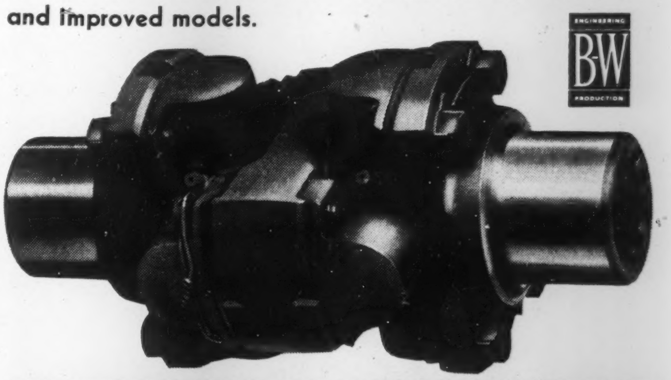


MECHANICS close-coupled type Roller Bearing UNIVERSAL JOINTS are specially designed for operation within cramped quarters, and where shafts are out of alignment. These joints fit into spaces that engineers formerly considered too short for universal joints.

Unique features of MECHANICS Roller Bearing UNIVERSAL JOINTS make them unusually easy to install and service. The complete cross and bearing assembly can be removed simply by taking out the cap screws and separating the end yokes slightly. No flange is required for drive shaft connections. Accurately and durably built for long, heavy service, MECHANICS Roller Bearing UNIVERSAL JOINTS are inherently balanced for smooth operation.

Let our engineers show you how MECHANICS close-coupled Roller Bearing UNIVERSAL JOINTS will conserve space and compensate for offset shafts, in your new and improved models.

ENGINEERING BW PRODUCTION



MECHANICS UNIVERSAL JOINT DIVISION

Borg-Warner • 2026 Harrison Ave., Rockford, Ill.

Scrub Happy!

• Somebody changed his mind a few times, or maybe the tracer was having a bad day. Just why isn't important. The point is the tracing had to be done over because erasing had given it a distinctly "scrub happy" look. Arkwright would have saved all this.

Erasures mean little to Arkwright. It takes erasure after erasure without wearing through, without line feathering when you re-ink.

Why not check Arkwright's advantages yourself, in your own drawing room, at our expense. Send for working samples, free. Arkwright Finishing Company, Providence, R. I.

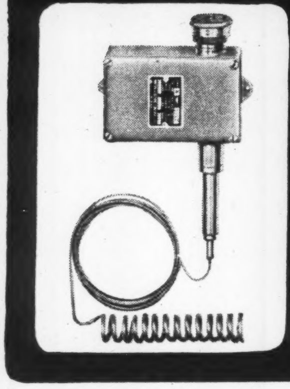
All Arkwright Tracing Cloths have these 6 important advantages

1 *Erasures re-ink without "feathering".*
2 *Prints are always sharp and clean.*
3 *Tracings never discolor or become brittle.*
4 *No surface oils, soaps or waxes to dry out.*
5 *No pinholes or thick threads.*
6 *Mechanical processing creates permanent transparency.*

Arkwright
PENCIL CLOTH
WHITE
Arkwright
TRACING CLOTH
Matsurf
PENCIL TRACING CLOTH

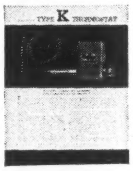
Arkwright
TRACING CLOTHS
AMERICA'S STANDARD FOR OVER 25 YEARS

THE TYPE K THERMOSTAT
FOR
Air
Liquid
Hot plate
APPLICATIONS
FROM —120°F TO +600°F



Within limits of —120°F to +600°F, the Type K Thermostat meets practically every air, liquid and hot plate application. These precision units have micrometer adjustment with calibration correction device and with equivalent centigrade readings. Short or wide ranges may be used with equal facility and accuracy. The bellows, bulb, and tube assemblies are solidly liquid-filled for positive, accurate control. The Type K is compensated for ambient temperature effect. Complete details on the 5 standard models will be found in Bulletin 441T—write for your copy.

Models for ranges —120° to 180° and 50° to 600°



United Electric Controls Company
DEPT. B, 69-71 A STREET, BOSTON 27, MASS.

Millons of
Billings Wrenches
carry this
Trade Mark

B

If it's a
FORGING
See Billings

The simple, rugged forged parts are daily routine. Mixed in are the precision close tolerance jobs. They're all the same to Billings Forging Engineers—Production!

WRITE OUR FORGINGS DIV. Dept. SF-2

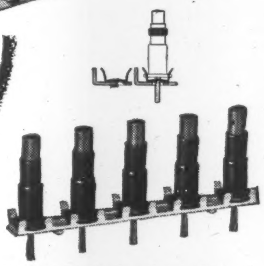
THE BILLINGS & SPENCER CO.
MAIN OFFICE AND PLANT
HARTFORD, CONN. U. S. A.

THIS

IS A SPEED NUT*

and

THIS *is also a* SPEED NUT



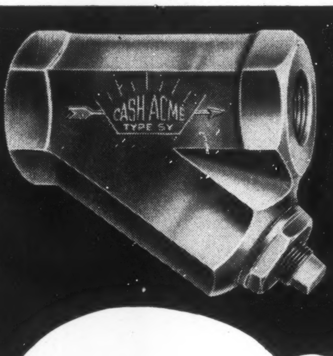
Here you see five SPEED NUTS combined into one, to simplify and improve the assembly of multiple coil forms on radios. This one ingenious fastener replaced eight separate parts and eliminated drilling and tapping operations. It retains tuning cores and screws, provides the right tension on screws, and its spring arms hold the plastic coil tubes securely in place. Just one example of hundreds.

SPEED NUT brand fasteners may be the answer to your quest for lower assembly costs too. Send us your engineering details and we'll give you a complete, no-charge analysis.

TINNERMAN PRODUCTS, INC.
2085 Fulton Road, Cleveland, Ohio

*Speed Nuts**
PATENTED
MORE THAN 4000 SHAPES AND SIZES
*Trade Mark Reg. U. S. Pat. Off.

FASTEST THING IN FASTENINGS



STOP SLUDGE!

Nothing can damage expensive pressure control equipment quicker than a bit of dirt, pipe scale, or foreign material in the working parts.

Protect this expensive equipment by the proper installation of a good sturdy strainer in the line just ahead.

The new CASH·ACME "Y" Type Strainer is ruggedly built around two hundred and fifty pound cast iron standards.

BRASS AND CAST IRON AVAILABLE.
1/8″ TO 2″ PIPE SIZES.
STANDARD OR SPECIAL SCREEN.

Write for descriptive Bulletin No. 224 for complete information.

STRAINERS
Stop Sludge!
Bulletin No. 224
DECATUR · ILLINOIS

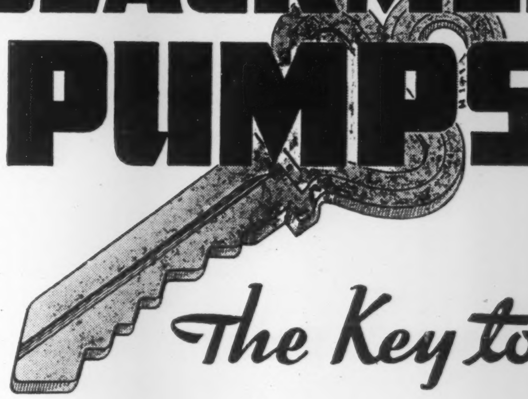
See your Mill Supply dealer
ask for CASH·ACME Automatic Valves.

Manufacturing SPECIALISTS OF
CASH-ACME
Automatic PRESSURE CONTROL VALVES

STOCK-CATALOG-SELL
CASH·ACME Products

A.W. CASH VALVE MFG. CORP.
6614 EAST WABASH AVE.
DECATUR ILLINOIS

BLACKMER PUMPS



The Key to

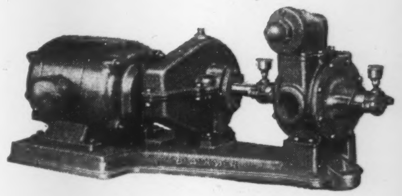
- **LOWER PUMPING COSTS**
- **SUSTAINED PUMPING CAPACITY**
- **PUMP DEPENDABILITY**

Write for Bulletin No. 307

FACTS about ROTARY PUMPS
BLACKMER

FACTS ABOUT ROTARY PUMPS

which explains why the "Bucket Design" (swinging vane principle) maintains pumping capacity by automatically compensating for wear and how the buckets, when finally worn out, are easily replaced and the pump restored to its normal capacity.



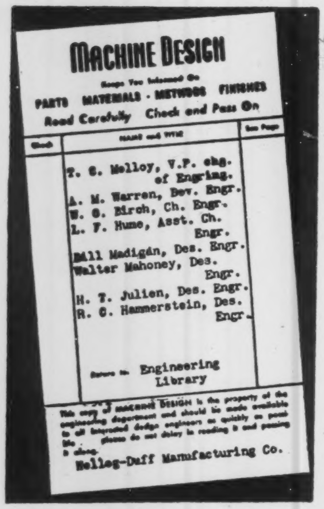
OUR ENGINEERS ARE AT YOUR SERVICE

BLACKMER PUMP COMPANY
1970 Century Avenue Grand Rapids 9, Michigan

POWER PUMPS - HAND PUMPS · EZY-KLEEN STRAINERS ·

Routing Slips

MAKE MACHINE DESIGN AVAILABLE TO ADDITIONAL DESIGN ENGINEERS



MACHINE DESIGN

PARTS MATERIALS · METHODS FINISHES

Read Carefully Check and Pass On

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A. M. Warren, Dev. Engr.
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ECONOMICAL—DURABLE

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SEE YOUR DEALER
OR WRITE

E & G PRODUCTS
13364 EVANSTON
DETROIT 13, MICH.

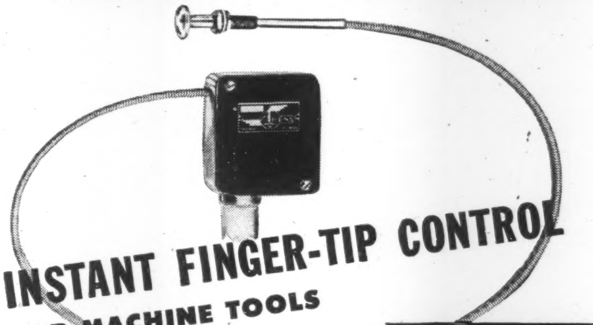
It's VIBRATION FREE!
It's SMOOTH!
It's QUIET!

Cyclohm | **SYNCHRONOUS CAPACITOR TYPE MOTOR**

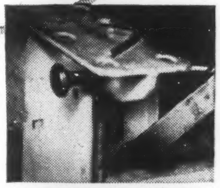
This new Cyclohm 29 Size has no equal as a synchronous, capacitor type motor for recording, tape pulling, facsimile work and other jobs which require a *quiet, smooth, vibrationless* motor. Internal rotor slots permit a higher starting torque and a quieter performance. Substantial cap seats, turned in the frame and end caps, ensure perfect rigidity, accurate bearing alignment, uniform air gap, and a vibration-free motor. Supplied with either ball bearings or sleeve bearings — in ratings of 1/100, 1/75 and 1/50 horsepower, 1800 r.p.m., 115 volts, 60 cycles. Write for complete information.

CYCLOHM MOTOR CORP.
5-17 46th Road, Long Island City 1, N.Y.

REMOTE SWITCH CONTROL



INSTANT FINGER-TIP CONTROL
FOR MACHINE TOOLS



Many Models Available
Standard Models (such as the installation above) as well as special units are available for any type of machine tool operation. This control is also particularly economical for installation on multiple units.

Here's the new low-cost Arens Remote Switch Control which provides instant starting and stopping for machine tools without rewiring. It also reduces machine tool installation costs and provides greater safety.

The control head may be quickly mounted on the machine at the point most convenient for the operator. The flexible cable can then be carried to the switch box which may be located either adjacent to the motor or convenient to present wiring or junction box.

If desired the control head may be mounted so the operator with body pressure against the switch button can turn the machine off.

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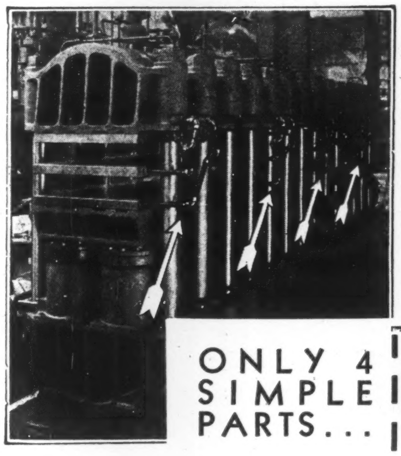
for Free Movement and Unrestricted Flow—
FLEXO JOINTS



The arrows point to connections made up of Flexo Joints and standard pipe. These connections keep the steam platens on these massive presses functioning safely and dependably—with minimum maintenance. Flexo Joints are sturdy, simple and accurate in their construction—give full 360° range of movement with completely unrestricted flow in all positions.

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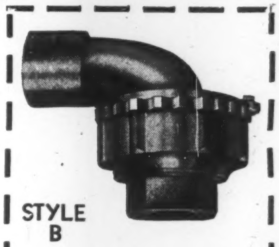
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No small parts, no springs, no ground surfaces to wear. Fully enclosed from grit and dirt. In four styles—standard pipe sizes from ¼" to 3".

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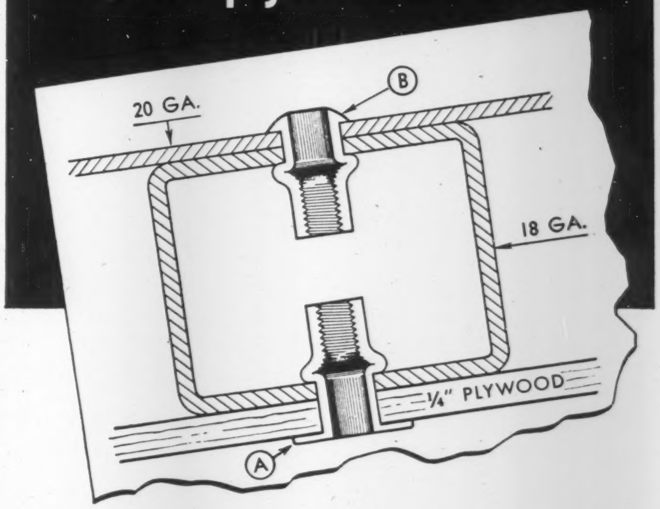
In Canada: S. A. Armstrong, Ltd., 115 Dupont St., Toronto, Ont.

New, better way to fasten plywood to steel



Trailer designers had the problem of securing ¼" plywood walls to 18 gage tubular steel sections with rivets that would not be pulled through the plywood under stress or vibrate loose in service. They found the answer in the new B. F. Goodrich Rivnut with the large washer head.

Rivnut "A" is easier to install than either wood screws or self-tapping screws. It fits flush with the plywood, requires no wood filler. Rivnut "B" fastens either 1 or 2 sheets of 20 gage steel to the opposite side of the section.

Both Rivnuts serve as blind rivets and nut plates too. Costs for the whole operation are reduced. If you have a fastening problem, chances are there's a Rivnut that will solve it. Why not write today for complete information?

➡ Get fastening facts in new "RIVNUT DATA BOOK"

Included in the 40 fully-illustrated pages of the new edition are step-by-step drawings of how Rivnuts work. Types, sizes, applications and test data are conveniently listed. For your free copy, write to The B. F. Goodrich Company, Dept. MD-67, Akron, Ohio.

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Rivnut
DATA BOOK

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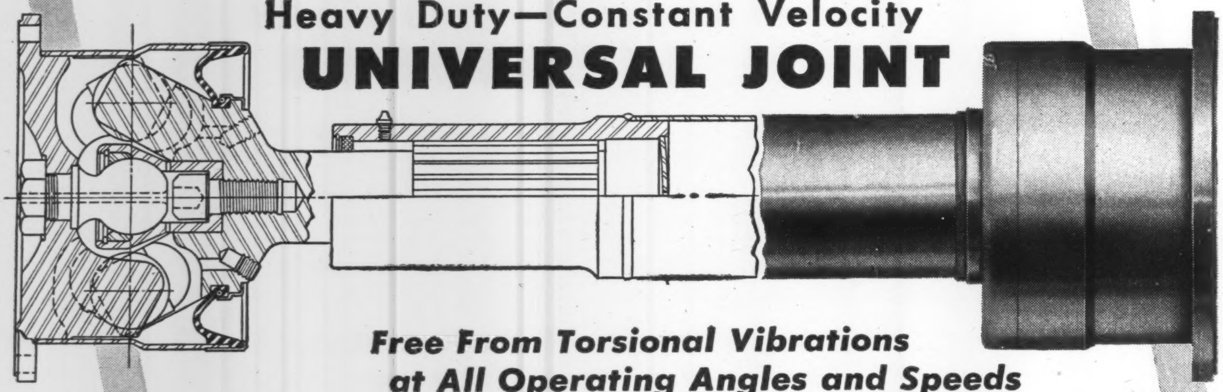
RIVNUTS
It's a rivet—It's a nutplate

The New **GEARGRIND**
Heavy Duty—Constant Velocity
UNIVERSAL JOINT



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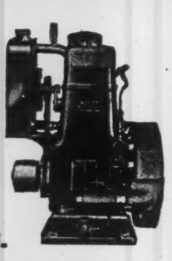

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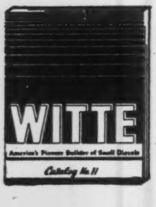

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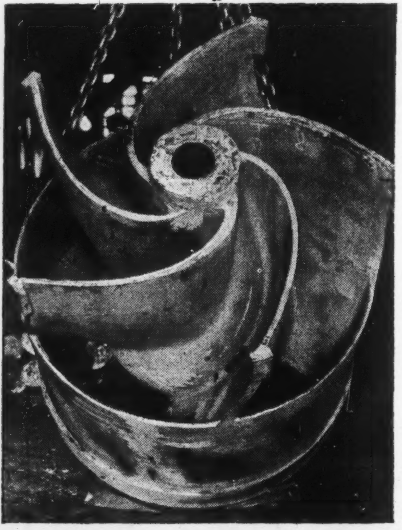

We made several of these big Casing Guide Vanes, as shown by the photo of the rough casting, left . . . the alloy was 88% copper, 10% tin and 2% zinc.

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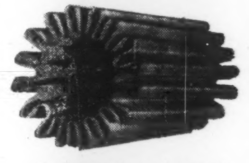

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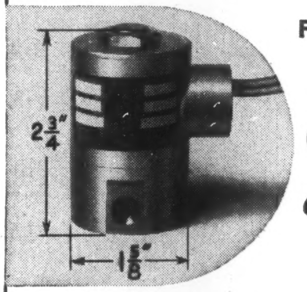

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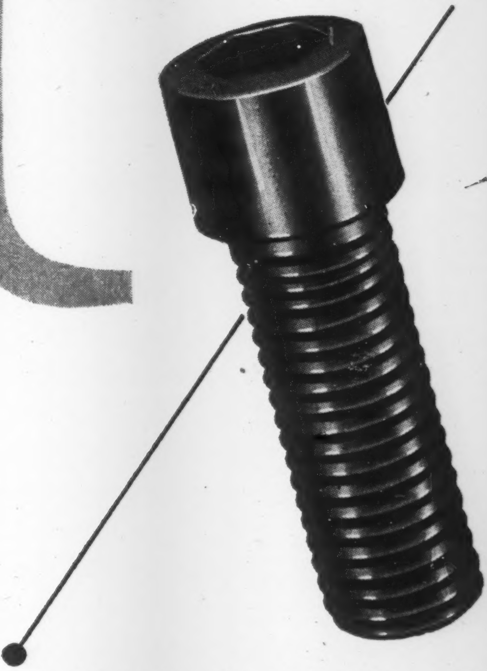

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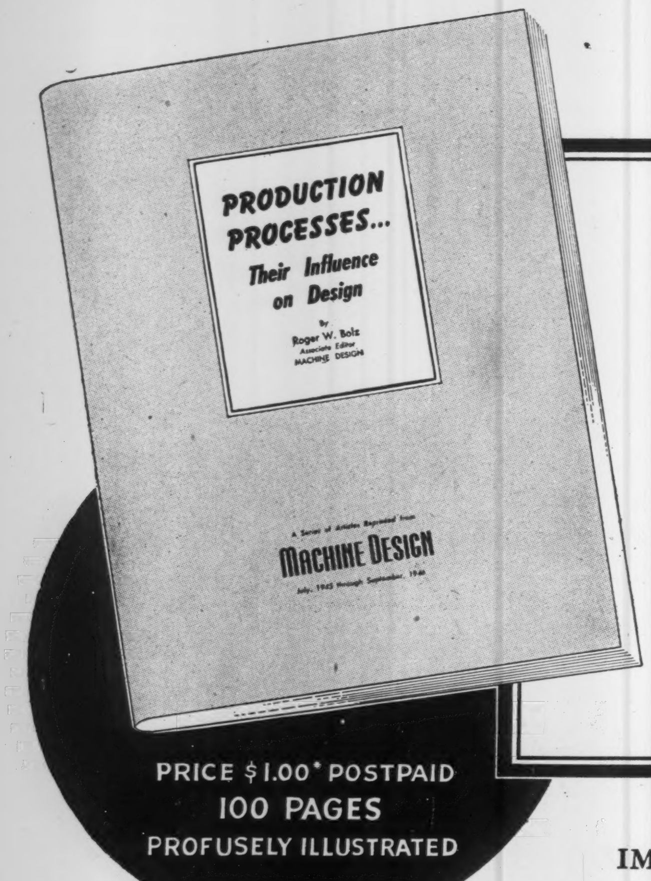
PRODUCTION PROCESSES...
Their Influence on Design
By
Roger W. Bolz
Associate Editor
MACHINE DESIGN
A Series of Articles Reprinted from
MACHINE DESIGN
July, 1945 through September, 1946

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By Roger W. Bolz
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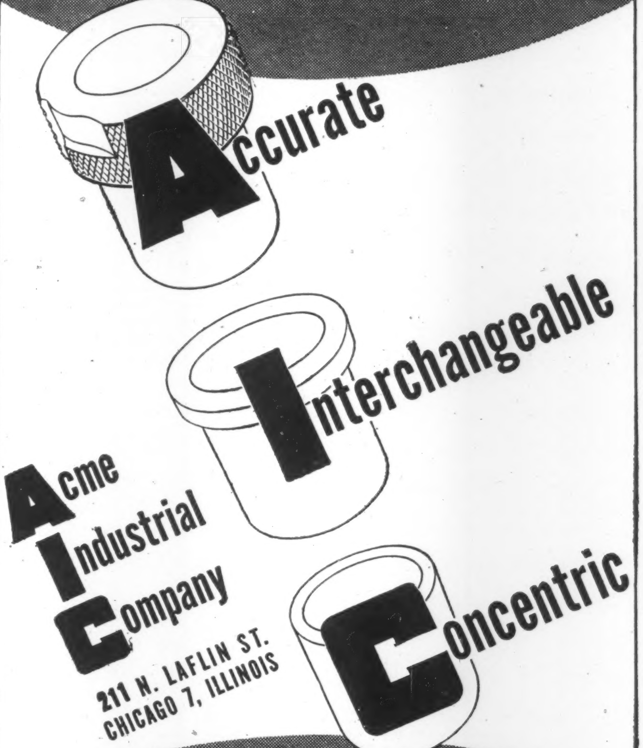

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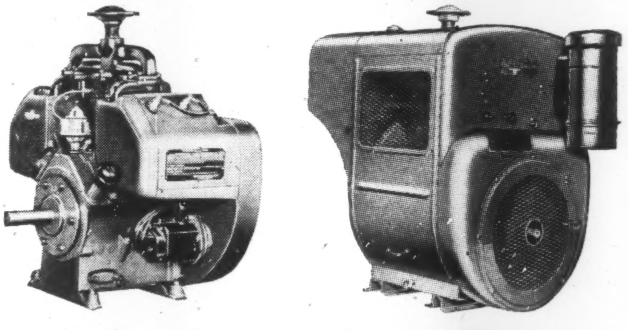

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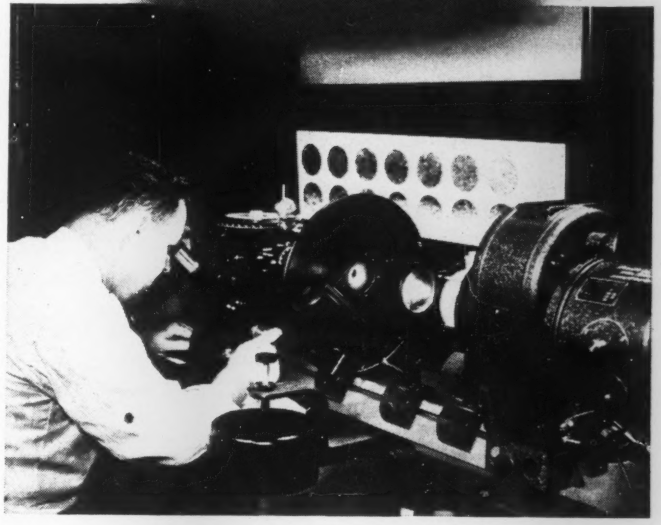

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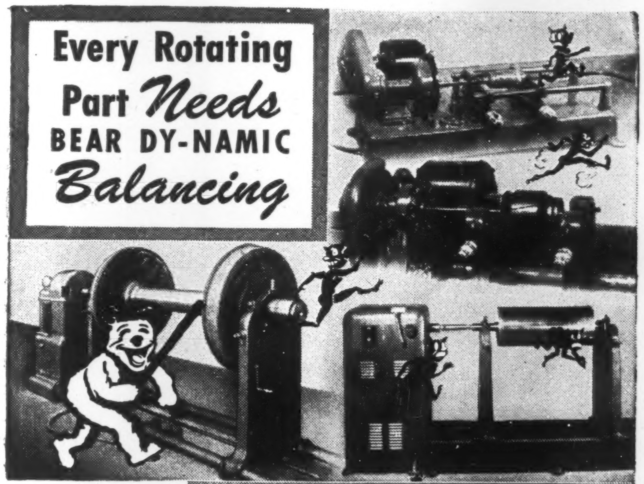
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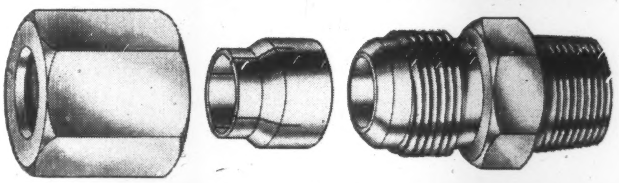
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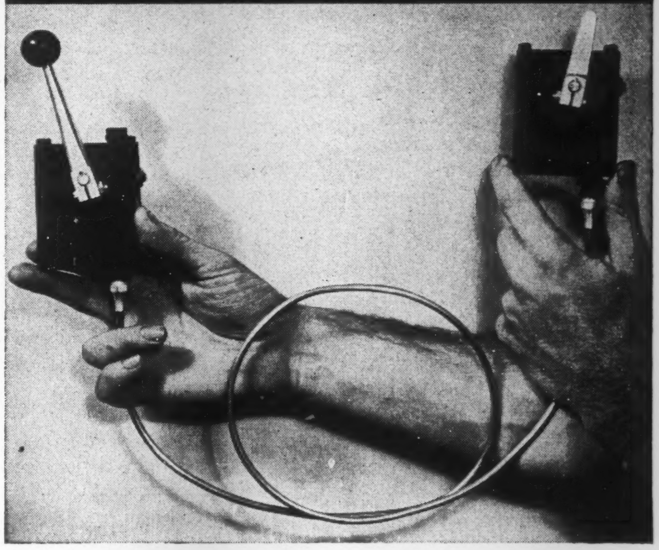
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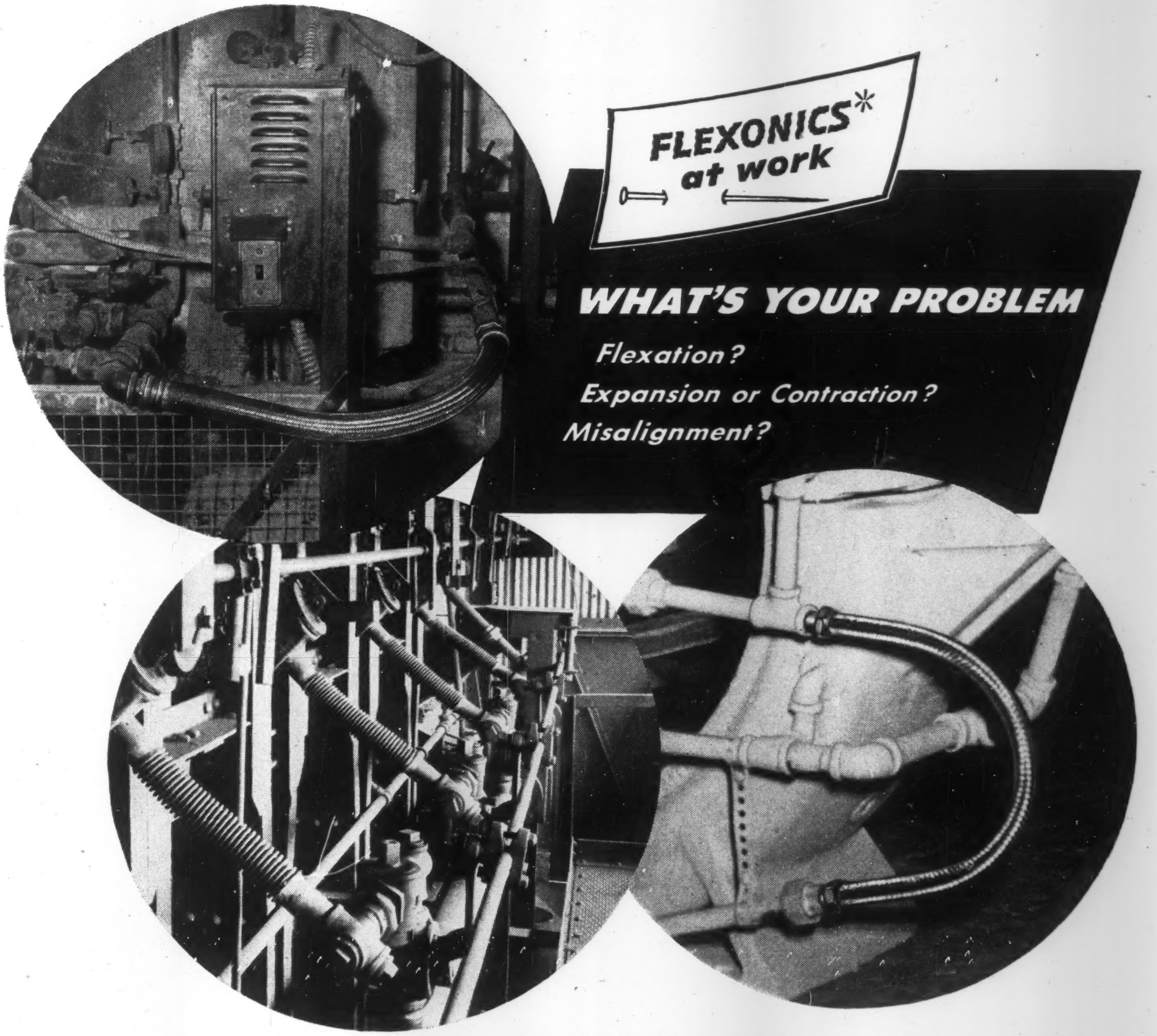
FLEXONICS* at work

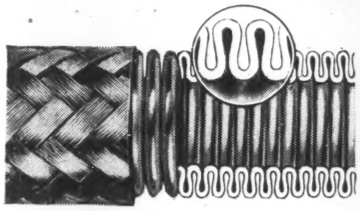
WHAT'S YOUR PROBLEM

Flexation?

Expansion or Contraction?

Misalignment?





Cutaway view of REX-WELD Flexible Metal Hose Type RW-81.

Whatever the service, it will pay you to investigate the versatility of *REX-WELD Flexible Metal Hose.* For this is the utility connection for most industrial uses. It offers a wide range of applications among which are included, in addition to these illustrated above; the handling of low to high-pressure steam; hot and cold gases, heavy and searching oils.

REX-WELD is highly serviceable under prolonged flexations, compensates for expansion or contraction, and may be readily installed to care for misalignment. It is made in one-piece continuous lengths up to 50 feet in *steel* or *bronze* and in size ranges from 3/16″ to 4″ I.D., inclusive. Send for data sheet.

***the science of FLEXONICS . . .**

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"FLEXON" *identifies C. M. H. products, which have served industry for more than 44 years.*

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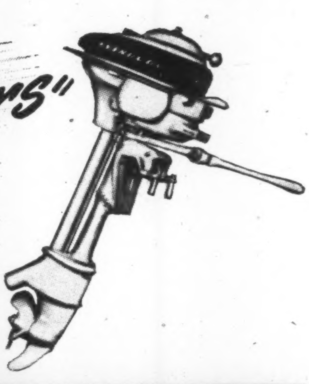
"Drive Faster... set up solid, without burrs" says EVINRUDE



NO WOBBLY STARTS *and slow driving to avoid skids here. Phillips Screws go in fast, set up tight and flush to hold cover of water jacket.*

DRIVING TIME CUT 30% *in fastening base plate to muffler assembly with Phillips Screws. Power driver centers and stays in recess—no slips.* ▶

TIGHT FASTENING *is essential in joining the two parts of die cast fuel tank, so Evinrude depends on Phillips Screws. Photo shows use of Phillips Screws for attaching nameplate where skids would mean expensive refinishing.*

★ ★ ★

. . . Key points of another study of assembly savings made with Phillips Screws in leading plants; from report of James O. Peck Co. independent investigator.

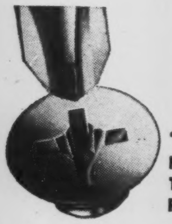
"Obvious assembly savings prompted our use of Phillips Head Screws in the 'Zephyr' Outboard Motor," explained Evinrude's Works Manager, "and results are even better than expected."

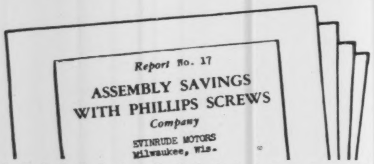
"Phillips Screws make the most of power tool speed. No lost motion as when driving slotted screws. We just bring the driver bit down and it automatically centers and seats in the Phillips Recess. That makes for a very fast operation . . . and an economical assembly. Also, we avoid driver skids, and subsequent expensive refinishing.

"We have to set 'em up solid, and the Phillips Recessed Head can take the necessary torque without breaking or burring. Outboards often get rough usage, and Phillips Screw fastenings match the sturdiness of the overall construction.

"Dangerous burrs avoided. Workmen can get bad cuts on hands and arms from sharp burrs common to slotted screws. With Phillips Screws, that hazard is banished, and the burr-free, ornamental recess has a much more shipshape appearance.

You'll find good ideas for your assembly operations in the complete report of this and other assembly studies . . . on metal, wood, and plastic products. Inside facts on modern methods of America's best assembly engineers. FREE—use coupon.





Report No. 17
ASSEMBLY SAVINGS
WITH PHILLIPS SCREWS
Company
EVINRUDE MOTORS
Milwaukee, Wis.

Phillips Screw Mfrs., c/o Horton-Noyes
1800 Industrial Trust Bldg.,
Providence, R. I. MD-18

Send me reports on **Assembly Savings with Phillips Screws.**

Name..

Company..

Address..

PHILLIPS *Recessed Head* SCREWS

Wood Screws • Machine Screws • Self-tapping Screws • Stove Bolts

23 SOURCES

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Corbin Screw Div. of
  American Hdwe. Corp.
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International Screw Co.
Lamson & Sessions Co.
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National Lock Co.
National Screw & Mfg. Co.
New England Screw Co.
Parker-Kalon Corporation
Pawtucket Screw Co.
Pheoll Manufacturing Co.
Reading Screw Co.
Russell Burdsall & Ward
  Bolt & Nut Co.
Scovill Manufacturing Co.
Shakeproof Inc.
The Southington Hardware Mfg. Co.
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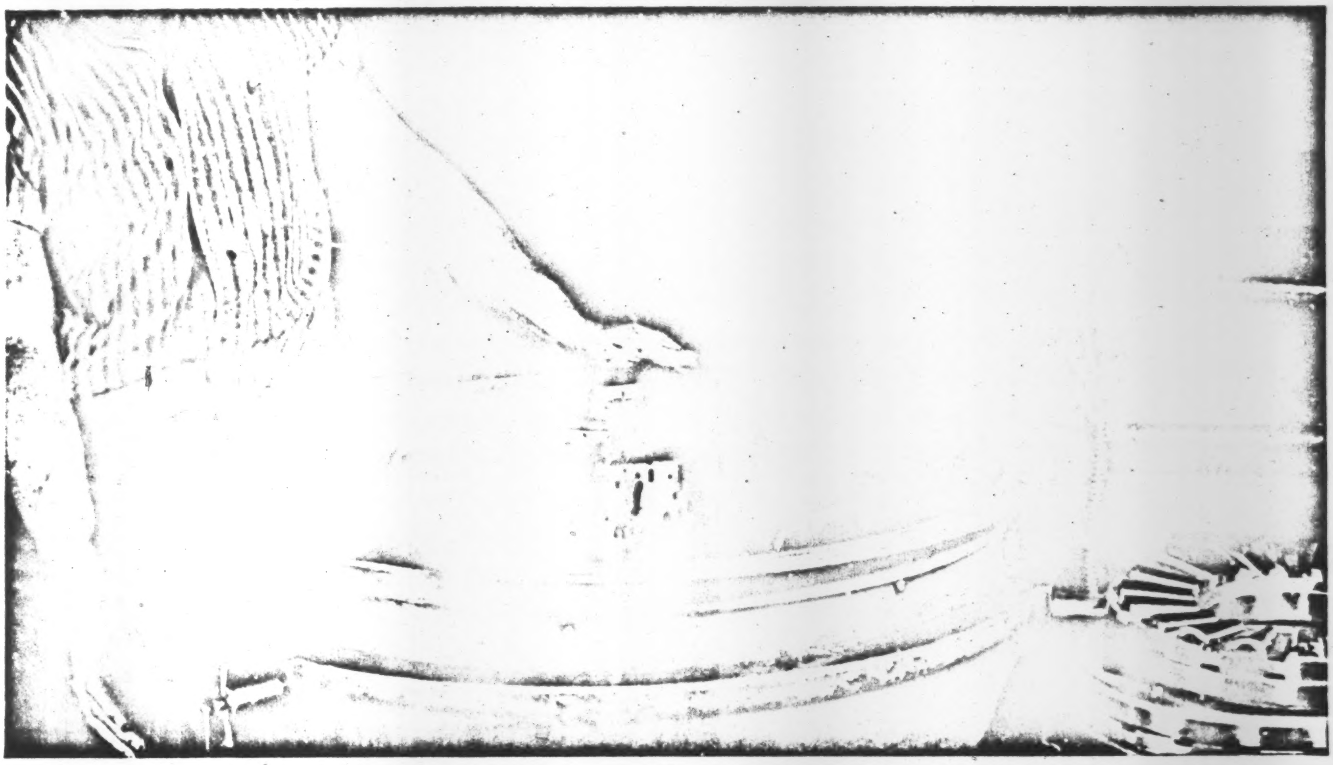
Stronghold Screw Products, Inc.
Wolverine Bolt Company

How Timken bearing development meets the specific needs of industry



He gives bearings a rub-down to put curves in the right places

THE operation shown here is typical of the many ways in which Timken tapered roller bearings are made to meet the specific needs of you who use them. As a final manufacturing process, certain types of Timken heavy duty thrust bearings are assembled and processed so that the surfaces of the ribs, rollers and races are generated as a unit. Through this special finishing operation, developed by Timken, the bearing becomes a "Generated Unit Assembly".

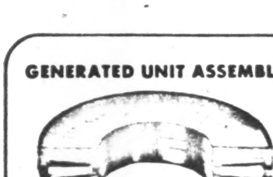
One of the important results of this extra manufacturing process is the generation of a smoothly curved area of contact between the end of each individual roller and the rib against which it operates, so that the convex shape of the roll end and the concave surface of the rib are identical in contour.

A minute detail? Perhaps. But, in certain applications, a tremendously important one. Timken developed this process many years ago for thrust bearings which must operate under excessive loads, with high pressures against the ribs. Today, Generated Unit Assembly increases capacity; reduces heat and friction; results in less wear and longer life; eliminates the need of breaking-in or final adjustment on the job; maintains positive roll alignment.

This careful attention to the literally thousands of minute details in the design and manufacture of Timken tapered roller bearings is your assurance of uniformly top quality and performance in the Timken bearings you use.

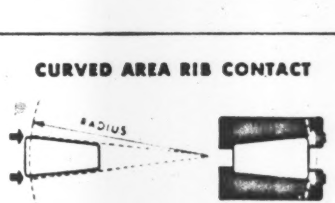
REMEMBER, Timken alone makes its own steel and is the acknowledged leader in: 1. advanced design; 2. precision manufacture; 3. rigid quality control; 4. special analysis steels. The Timken Roller Bearing Company, Canton 6, Ohio.

GENERATED UNIT ASSEMBLY

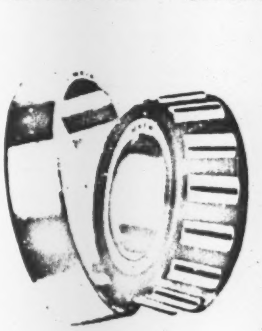


Extra manufacturing process makes Timken heavy duty thrust bearing a "Generated Unit Assembly".

CURVED AREA RIB CONTACT



Curved area of roll end (at arrows) fits perfectly the curve of upper and lower ribs of this thrust bearing.



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TRADE-MARK REG. U. S. PAT. OFF.

TAPERED ROLLER BEARINGS

NOT JUST A BALL ○ NOT JUST A ROLLER ▭ THE TIMKEN TAPERED ROLLER ▭ BEARING TAKES RADIAL ↕ AND THRUST → ← LOADS OR ANY COMBINATION ✳